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COMMITTEE ON THE PEACEFUL
USES OF OUTER SPACE

# REPORT OF THE SCIENTIFIC AND TECHNICAL SUBCOMMITTEE ON THE WORK OF ITS THIRTY-SECOND SESSION

## INTRODUCTION

1. The Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space held its thirty-second session at the United Nations Office at Vienna from 6 to 16 February 1995 under the chairmanship of Professor J. H. Carver (Australia).

2. Representatives of the following Member States attended the session: Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, China, Colombia, Cuba, Czech Republic, Ecuador, Egypt, France, Germany, Greece, Hungary, India, Indonesia, Iran (Islamic Republic of), Iraq, Italy, Japan, Lebanon, Mexico, Morocco, Netherlands, Nicaragua, Nigeria, Pakistan, Philippines, Poland, Portugal, Republic of Korea, Romania, Russian Federation, South Africa, Spain, Sudan, Sweden, Syrian Arab Republic, Turkey, Ukraine, United Kingdom of Great Britain and Northern Ireland, United States of America, Uruguay and Venezuela.

3. Representatives of the following specialized agencies attended the session: Food and Agriculture Organization of the United Nations (FAO), United Nations Educational, Scientific and Cultural Organization (UNESCO), International Civil Aviation Organization (ICAO), World Health Organization (WHO), International Telecommunication Union (ITU), World Meteorological Organization (WMO), United Nations Industrial Development Organization (UNIDO) and International Atomic Energy Agency (IAEA).

4. Representatives of the Association of Space Explorers (ASE), European Space Agency (ESA), Committee on Space Research (COSPAR) of the International Council of Scientific Unions (ICSU), International Astronautical Federation (IAF) and International Society for Photogrammetry and Remote Sensing (ISPRS) also attended the session.

5. A list of the representatives of Member States, specialized agencies and other international organizations attending the session is contained in document A/AC.105/C.1/INF.24.

6. On 6 February, the Subcommittee adopted the following agenda:

   1. Adoption of the agenda.

   2. Statement by the Chairman.

   3. General exchange of views.

4. United Nations Programme on Space Applications and the coordination of space activities within the United Nations system.

5. Implementation of the recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space.

6. Matters relating to remote sensing of the Earth by satellites, including, inter alia, applications for developing countries.

7. Use of nuclear power sources in outer space.

8. Space debris.

9. Questions relating to space transportation systems and their implications for future activities in space.

10. Examination of the physical nature and technical attributes of the geostationary orbit; examination of its utilization and applications, including, inter alia, in the field of space communications, as well as other questions relating to space communications developments, taking particular account of the needs and interests of developing countries.

11. Matters relating to life sciences, including space medicine.

12. Progress in national and international space activities related to the Earth environment, in particular progress in the Geosphere-Biosphere Programme (Global Change).

13. Matters relating to planetary exploration.

14. Matters relating to astronomy.

15. The theme fixed for special attention at the 1995 session of the Scientific and Technical Subcommittee: "Application of space technology for education, with particular emphasis on its use in developing countries".

16. Other matters.

17. Report to the Committee on the Peaceful Uses of Outer Space.

## A. Meetings and documentation

7. The Subcommittee held 17 meetings.

8. A list of the documents which were before the Subcommittee is provided in annex I to the present report.

9. Following the adoption of the agenda, the Chairman made a statement outlining the work of the Subcommittee at its current session and welcomed the new members of the Committee to the Subcommittee. He also reviewed the activities of States Members of the United Nations in the field of space exploration, including important advances that had been achieved as a result of international cooperation during the past year.

10. At the 448th, 449th, 450th and 452nd meetings, the Chairman informed the Subcommittee that requests had been received from the permanent representatives of Algeria, Ethiopia, Peru, Slovakia, Thailand and Tunisia, and from the League of Arab States, to attend the session. Following past practice, those delegations were invited to attend the current session of the Subcommittee and to address it as appropriate. That was without prejudice to further requests of that nature and did not involve any decision of the Subcommittee concerning status, but was a courtesy that the Subcommittee extended to those delegations.

11. General statements were made by the following delegations: Argentina, Austria, Brazil, Bulgaria, Canada, Chile, China, Colombia, Cuba, Czech Republic, Ecuador, France, Germany, Greece, Hungary, India, Indonesia, Iran (Islamic Republic of), Mexico, Morocco, Philippines, Republic of Korea, Romania, Russian Federation, South Africa, Spain, Sweden, Turkey, Ukraine, United Kingdom of Great Britain and Northern Ireland and United States of America. General statements were also made by the representatives of ITU, ASE, COSPAR and IAF.

12. At the 448th meeting, the Director of the Office for Outer Space Affairs made a statement reviewing the work programme of the Office. At the 452nd meeting, the Expert on Space Applications made a statement outlining the activities carried out and planned under the United Nations Programme on Space Applications.

## B. Technical presentations

13. In accordance with General Assembly resolution 49/34, paragraph 13 (b) (vii), of 9 December 1994, a symposium on the theme "Application of space technology for education, with particular emphasis on its use in developing countries" was organized by COSPAR and IAF to complement discussions within the Subcommittee on the special theme. The first session of the symposium, entitled "Policy issues regarding space education", was held on 6 February and was co-chaired by Mr. H. H. von Muldau, representing IAF, and Mr. K. Kasturirangan, representing COSPAR. The second session of the symposium, entitled "Applications of space technology in space education", was held on 7 February and was co-chaired by Mr. S. Bauer, representing COSPAR, and Mr. H. H. von Muldau, representing IAF. Mr. R. Gibson of IAF was the Rapporteur for both sessions of the symposium.

14. The presentations to the symposium included: "Applications for space technology for education: the Indian experience, solutions and perspectives of the future" by Mr. M. G. Chandrasekhar, Scientific Secretary, Indian Space Research Organization (ISRO); "French experience in space education" by Mr. L. Laidet, Directeur de la Communication du Centre national d'études spatiales (CNES); "South American perspectives on the application of space technology for education: the example of Brazil" by Ms. F. de Oliveira, Public Affairs Office, Instituto Nacional de Pesquisas Espaciais (INPE); "ISRO video: Interactive satellite-based television broadcasting systems for education and training - towards operational systems" by Mr. K. Kasturirangan, Chairman, ISRO; "Space education activities in the U.S." by Ms. Beth Masters, Director of International Relations, National Aeronautics and Space Administration (NASA); "University education in space science and engineering" by Mr. D. Abir, Tel Aviv University, Israel National Commission on Space Research; and "The intelligent satellite data information system ISIS of DLR" by Mr. G. Strunz, Deutsche Forschungsanstalt für Luft- und Raumfahrt e.V. (DLR), Deutsches Fernerkundungsdatenzentrum.

15. In response to General Assembly resolution 49/34, Mr. Y. Trempat, France, Mr. M. G. Chandrasekhar, India, Mr. E. Wnuk, Poland, Mr. Richard Crowther, United Kingdom and Mr. Walter Flury, ESA, made special presentations on the complex issue of space debris and the solutions currently being adopted at the national level.

16. During the course of the session, scientific and technical presentations were made by Mr. W. Elliott and Ms. W. Loly, Canada, on down-to-Earth education; Mr. W. Riedler, Austria, on spacecraft potential control

and related research; Mr. P. Korobenkov, ITU, on the ITU and international geostationary-satellite orbit/spectrum management; Mr. D. McNally, ICSU, on adverse environmental impacts on astronomy; Mr. H. Hinghofer-Szalkay, Austria, on ASM and the Russian long-term flight project; Mr. Brian Wade, AEA Technology, United Kingdom, on nuclear power sources; Ms. Yifang Ban, International Space University, on GATES: Global Access to Telehealth and Education Systems; Mr. V. Kojarnovitch, UNIDO, on spin-off benefits of space technology; Ms. M. Chevrel, CNES, on French space efforts in the area of the environment; Mr. V. S. Nikolaev, Russian Federation, Ministry of Atomic Energy, on nuclear power sources in outer space; Ms. Margaret Finarelli, Globe Program, United States, on the Globe Program; Mr. Jean-Claude Cazaux, SCOT Conseil, France, on the uses of SPOT in developing countries; Ms. Evgeniya Volokhova, Ministry of Education, Russian Federation, on the use of space technology for education; and Mr. Victor Iatsouk, Communications Section, ICAO, on the CNS/ATM Programme.

### C. Recommendations of the Scientific and Technical Subcommittee

17. After considering the various items before it, the Subcommittee, at its 464th meeting, on 16 February 1995, adopted its report to the Committee on the Peaceful Uses of Outer Space containing its views and recommendations as set out in the paragraphs below.

## I. UNITED NATIONS PROGRAMME ON SPACE APPLICATIONS AND THE COORDINATION OF SPACE ACTIVITIES WITHIN THE UNITED NATIONS SYSTEM

## II. IMPLEMENTATION OF THE RECOMMENDATIONS OF THE SECOND UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE

18. In accordance with General Assembly resolution 49/34, the Subcommittee continued its consideration of the above-mentioned items. In accordance with past practice, the Subcommittee considered the two items jointly.

19. The Subcommittee noted that the General Assembly, in resolution 49/34, paragraph 19, had once again emphasized the urgency and importance of implementing fully the recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82). The Subcommittee also took note of paragraph 14 of the same resolution, in which the General Assembly considered that, in the context of the Subcommittee's consideration of the item, it was particularly urgent to implement the following recommendations:

> "(a) All countries should have the opportunity to use the techniques resulting from medical studies in space;
>
> "(b) Data banks at the national and regional levels should be strengthened and expanded and an international space information service should be established to function as a centre of coordination;
>
> "(c) The United Nations should support the creation of adequate training centres at the regional level, linked, whenever possible, to institutions implementing space programmes; necessary funding for the development of such centres should be made available through financial institutions;
>
> "(d) The United Nations should organize a fellowship programme through which selected graduates or postgraduates from developing countries should get in-depth, long-term exposure to space technology

or applications; it is also desirable to encourage the availability of opportunities for such exposure on other bilateral and multilateral bases outside the United Nations system."

20. In response to the recommendations of the Working Group of the Whole to Evaluate the Implementation of the Recommendations of UNISPACE 82, contained in its report on the work of its eighth session, held in 1994 (A/AC.105/571, annex II, paras. 6-21), which were endorsed by the General Assembly in resolution 49/34, paragraph 16, the Subcommittee had before it the following documents: a report on international cooperation in the peaceful uses of outer space: activities of Member States (A/AC.105/592 and Adds.1, 2, 3 and 4), containing information submitted by Member States in response to paragraph 10 of the report of the Working Group; a technical study on the participation of developing countries in the Global Change Programme and possibilities of enhancing it (A/AC.105/590), in response to paragraph 17 (f); and a technical study on satellite-based radio broadcasting services (A/AC.105/591), in response to paragraph 17 (b). The Subcommittee also had before it the following document: a report on international cooperation in the peaceful uses of outer space: programmes of international organizations (A/AC.105/601), in response to paragraph 11 of the report of the Working Group. In addition, the Subcommittee had before it annual reports, including information in response to paragraph 11, submitted by the following international organizations: WMO (A/AC.105/597), European Telecommunications Satellite Organization (A/AC.105/598), International Telecommunications Satellite Organization (A/AC.105/599), European Organization for the Exploration of Meteorological Satellites (A/AC.105/600), ITU (A/AC.105/603) and ISPRS (A/AC.105/604).

21. In accordance with General Assembly resolution 49/34, paragraph 15, the Subcommittee reconvened the Working Group of the Whole with a view to improving the execution of activities relating to international cooperation, particularly those included in the United Nations Programme on Space Applications, and to proposing concrete steps to increase such cooperation as well as to make it more efficient. The Working Group of the Whole was chaired by Mr. Muhammed Jameel (Pakistan); it held four meetings between 8 and 16 February 1995 and adopted its report on 16 February 1995.

22. Having considered the report of the Working Group of the Whole, the Subcommittee decided at its 464th meeting, on 16 February 1995, to adopt that report, as contained in annex II to the present report, on the understanding that the recommendations contained therein would be carried out in accordance with General Assembly resolution 37/90, paragraph 9, of 10 December 1982. The Subcommittee recommended that the Working Group be reconvened next year to continue its work.

## A. United Nations Programme on Space Applications

23. Regarding the expanded United Nations Programme on Space Applications, the Subcommittee had before it the report of the United Nations Expert on Space Applications (A/AC.105/595). The report was supplemented by a statement by the Expert. The Subcommittee noted that the Programme on Space Applications for 1994 had been carried out satisfactorily and commended the work accomplished by the Expert in carrying out the work programme as endorsed by the Subcommittee at its previous session.

24. The Subcommittee noted with appreciation that since its previous session additional contributions had been offered by various Member States and organizations and that they had been acknowledged in paragraph 72 of the Expert's report.

25. The Subcommittee continued to express its concern over the still limited financial resources available for carrying out the Programme and appealed to Member States to support the Programme through voluntary contributions. The Subcommittee felt that the limited resources of the United Nations should be focused on the highest priority activities and noted that the Programme on Space Applications was the priority activity of the Office for Outer Space Affairs.

## 1. 1994-1995

### (a) United Nations training courses, workshops, conferences and symposia

26. With regard to the activities of the programme carried out in 1994, the Subcommittee expressed its appreciation to the following:

(a) The Government of Italy for co-sponsoring, through the United Nations Trust Fund for New and Renewable Sources of Energy, the United Nations/ESA Training Course for Latin American and Caribbean Countries on the Monitoring of Natural Resources, Renewable Sources of Energy and the Environment using Data from ERS-1, organized jointly with the Department for Development Support and Management Services of the United Nations, hosted by the European Space Research Institute (ESRIN) of ESA and held at Frascati, Italy, from 18 to 28 April 1994 and at Rome on 29 April 1994;

(b) The Government of Sweden, represented by the Swedish Board for Investment and Technical Support (BITS), for co-sponsoring the Fourth United Nations Training Course on Remote Sensing Education for Educators, hosted by Stockholm University and the Swedish Space Corporation Satellitbild and held at Stockholm and Kiruna, Sweden, from 2 May to 10 June 1994;

(c) The Government of Egypt, for co-sponsoring the Fourth United Nations/ESA Workshop on Basic Space Science, held at Cairo, Egypt, from 27 June to 1 July 1994;

(d) The Government of China, for co-sponsoring the United Nations/ESA Workshop on Microwave Remote Sensing Applications, hosted by the State Science and Technology Commission of China (SSTCC) and its National Remote Sensing Centre (NRSC) and held in Beijing, from 14 to 18 September 1994;

(e) The Government of Peru, for co-sponsoring the United Nations/ESA Workshop on Global Change and the Training Course on Microwave Remote Sensing Applications, hosted by the Comisión Nacional de Investigación y Desarrollo Aeroespacial (CONIDA) and held consecutively from 3 to 4 and from 5 to 14 October 1994, respectively, at the headquarters of CONIDA at Lima;

(f) The Government of Austria, as well as the State of Styria, the City of Graz and ESA, for co-sponsoring the United Nations Workshop on Enhancing Social, Economic and Environmental Security through Space Technology, hosted by the Austrian Federal Ministry for Foreign Affairs and held at Graz, Austria, from 12 to 15 September 1994;

(g) ESA and the Commission of the European Communities (CEC), for co-sponsoring the United Nations/International Astronautical Federation Symposium on Benefits of Space Technology for the Developing World: from Economic Growth to Environmental Protection, hosted by the Israeli National Committee on Space Research (NCSR) and held in conjunction with the 45th IAF Congress in Israel, from 6 to 9 October 1994.

27. The Subcommittee took note of the status of the planned United Nations workshops, training courses and conferences being held in 1995, which included the following activities, as described in the Expert's report (A/AC.105/595, annex III):

(a) United Nations Meeting of Experts on the Development of Education Curricula for the Centres for Space Science and Technology Education, being organized in cooperation with the Government of Spain, to be held at Granada, from 27 February to 3 March 1995;

(b) Fifth United Nations/Sweden International Training Course on Remote Sensing Education for Educators, being organized in cooperation with the Government of Sweden, to be held at Stockholm, from 1 May to 9 June 1995;

(c) United Nations/ESA International Microwave Remote Sensing Training Course for Asia and the Pacific countries on Applications of ERS-1 Data for Natural Resources, Renewable Energy and the Environment, being organized jointly with the Department for Development Support and Management Services of the United Nations, and to be held at ESRIN, Frascati, Italy, from 28 April to 5 May 1995;

(d) United Nations/ESA Training Course on the Use of ERS-1 Data for Mapping and Inventory of Natural Resources in Africa, being organized for the benefit of African French-speaking countries, to be held at Libreville, Gabon, from 15 to 19 May 1995;

(e) United Nations/ESA Workshop on the Applications of Space Techniques to Prevent and Combat Disasters, being organized for the benefit of African English-speaking countries, to be held at Harare, Zimbabwe, from 22 to 26 May 1995;

(f) United Nations/INTA/ESA International Workshop on Small Satellite Missions, being organized in cooperation with the Government of Spain, to be held at Madrid, Spain, from 13-17 November 1995;

(g) United Nations/USA International Workshop on Spin-off Benefits of Space Technology: Challenges and Opportunities, being organized in cooperation with the Government of the United States of America, to be held from 16 to 20 October 1995;

(h) United Nations Regional Conference on Space Technology for Sustainable Development in Latin America and the Caribbean, being organized in cooperation with the Government of Mexico and ESA, to be held at Puerto Vallarta, Mexico, from 30 October to 3 November 1995;

(i) Fifth United Nations/ESA Workshop on Basic Space Science, being organized in cooperation with the Government of Pakistan for the benefit of Member States in the Asia and the Pacific region, to be held at Karachi, from 6 to 10 November 1995;

(j) United Nations/International Centre for Theoretical Physics Workshop on Optics in Space Science and Technology, to be held at Trieste, Italy, from 20 to 25 November 1995;

(k) United Nations Workshop on the Use of Space Techniques for the Monitoring and Control of the Desert Environment, being organized in cooperation with the Government of the Syrian Arab Republic for the benefit of Member States in the Economic and Social Commission for Western Asia region, to be held at Damascus, Syrian Arab Republic, from 20 to 24 November 1995;

(l) United Nations/Austria/ESA Workshop on Benefits of Space Technology, being organized in cooperation with the Government of Austria, the State of Styria, the City of Graz and ESA, to be held at Graz, Austria, from 4 to 7 September 1995;

(m) United Nations/IAF/CEC/ESA Workshop on Space Technology for the Developing World, being organized in cooperation with the Government of Norway, to be held at Oslo, from 29 September to 1 October 1995.

(b) Long-term fellowships for in-depth training

28. The Subcommittee expressed appreciation to the Governments of Brazil and China as well as to ESA for having offered training fellowships in various areas relating to space activities for the period 1993-1994. The Subcommittee once again expressed appreciation to those Governments and agencies who had offered to renew fellowships for the period 1994-1995. The status of the 1994-1995 fellowships and the countries whose candidates have received fellowships were indicated in annex II of the Expert's report.

29. The Subcommittee noted that it was important to increase the opportunities for in-depth education in all areas of space science, technology and applications projects through long-term fellowships.

(c) Technical advisory services

30. The Subcommittee took note of the technical advisory services being provided by the Programme on Space Applications of the Office for Outer Space Affairs in support of regional space applications projects, as indicated in the report of the Expert:

(a) Collaboration with ESA on a survey and selection of projects to receive remote-sensing data made available by ESA to African countries covered by two ESA remote-sensing ground receiving stations at Maspalomas, Spain and Fucino, Italy;

(b) Assistance to the Government of Ecuador in promoting regional operation, administration and funding of the remote sensing receiving station at Cotopaxi, Ecuador;

(c) Assistance to the Government of Chile in its follow-up, as pro tempore secretariat, of the recommendations of the Second Space Conference of the Americas;

(d) Assistance to the Government of the Republic of Korea in the establishment of the Asia-Pacific Satellite Communications Council;

(e) Collaboration with ESA on the implementation of a project, entitled COPINE. This project will address one of the recommendations of the Dakar Regional Conference on Space Technology for Sustainable Development in Africa, held in October 1993, regarding the urgent need to establish an efficient communications network/linkage among African professionals and scientists at national, subregional and continental levels;

(f) Collaboration with ESA and the Department for Development Support and Management Services of the United Nations in follow-up activities related to the recommendations of the April 1994 Training Course on Applications of ERS-1 Data for Natural Resources, Renewable Energy and the Environment, held at Frascati, Italy.

(d) Promotion of greater cooperation in space science and technology

31. The Subcommittee noted that the United Nations was collaborating with international professional bodies in the space community to promote exchange of experience on space activities and that in this respect, the Office for Outer Space Affairs is co-sponsoring, together with the Explorers Club, the International Conference on Near Earth Objects, to be held in New York from 24 to 26 April 1995, and co-sponsoring, together with the Hungarian Institute for Geodesy, Cartography and Remote Sensing, the Third International Seminar on the Global Positioning System in Central Europe, to be held at Penc, Hungary, in May 1995. In this connection, in 1994, the Programme on Space Applications co-sponsored the following activities:

(a) A United Nations/IAF/CEC/ESA Symposium on Benefits of Space Technology for the Developing World: From Economic Growth to Environmental Protection, held in Israel, from 6 to 9 October 1994, in conjunction with the 45th IAF Congress;

(b) A United Nations/APSCC/Republic of Korea Workshop on Satellite Communications, held at Seoul, from 26 to 29 October 1994.

### 2. 1996

#### (a) United Nations training courses, workshops and symposia

32. The Subcommittee recommended the approval of the following programme of training courses, workshops and symposia proposed for 1996:

(a) Sixth United Nations/Sweden International Training Course on Remote Sensing Education for Educators;

(b) Second United Nations Regional Conference on Space Technology for Sustainable Development in Africa;

(c) Sixth United Nations/ESA Workshop on Basic Space Science;

(d) Second United Nations Workshop on Spin-off Benefits of Space Exploration;

(e) United Nations/ESA International Microwave Remote Sensing Training Course;

(f) Second Workshop on Payloads on Small Satellites;

(g) United Nations International Training Course on Communications Technology for Development;

(h) United Nations Workshop on Radar Remote Sensing Applications;

(i) United Nations Workshop on the Prevention and Mitigation of Effects of Natural Disasters.

## B. International space information service

33. The Subcommittee noted with satisfaction that the Office for Outer Space Affairs was in the process of developing an international space information system, including both information within the United Nations system and access to external databases.

34. The Subcommittee noted with satisfaction the publication of a document entitled "Seminars of the United Nations Programme on Space Applications: selected papers on remote sensing, satellite communications and space science" (A/AC.105/584).

## C. Reports

35. The Subcommittee took note with appreciation of the reports submitted to it by Member States and international organizations in response to the recommendations of the Working Group of the Whole in its

report on the work of its eighth session. It also noted with satisfaction that the Secretariat had prepared technical studies on the participation of developing countries in the Global Change Programme and their possibilities of contributing to it (A/AC.105/590), and on satellite-based radio broadcasting services (A/AC.105/591).

### D. Coordination of space activities within the United Nations system and inter-agency cooperation

36. The Subcommittee noted that the General Assembly, in its resolution 49/34, had reaffirmed its request to all organs, organizations and bodies of the United Nations system and other intergovernmental organizations working in the field of outer space or on space-related matters to cooperate in the implementation of the recommendations of UNISPACE 82.

37. The Subcommittee noted with satisfaction that the Inter-Agency Meeting on Outer Space Activities was convened at the United Nations Office at Vienna, from 3 to 5 October 1994, and that its report (A/AC.105/582) was before the Subcommittee. The Subcommittee took note of the information provided on the progress achieved in coordinating the space activities of the organizations of the United Nations system and expressed its appreciation for the report of the Secretary-General entitled "Coordination of outer space activities within the United Nations system: programmes of work for 1995 and 1996 and future years" (A/AC.105/587).

38. The Subcommittee continued to stress the necessity of ensuring continuous and effective consultations and coordination in the field of outer space activities among organizations within the United Nations system and the avoidance of duplication of activities. The Subcommittee noted that future sessions of the Inter-Agency Meeting on Outer Space Activities would be convened at the United Nations Office at Vienna, and hosted by the Office for Outer Space Affairs, during late September or early October each year, without prejudice to any invitation by an interested agency to host a session at its headquarters.

### E. Regional and interregional cooperation

39. The Subcommittee noted that the General Assembly, in its resolution 49/34, had reaffirmed its approval of the recommendations of UNISPACE 82 regarding the establishment and strengthening of regional mechanisms of cooperation, and their promotion and creation through the United Nations system. The Subcommittee noted with satisfaction that, in carrying out various activities in the implementation of the recommendations of UNISPACE 82, the Secretariat had sought to strengthen those mechanisms.

40. The Subcommittee noted with appreciation the efforts undertaken as part of the United Nations Programme on Space Applications, in accordance with the UNISPACE 82 recommendation concerning the development of indigenous capabilities, to establish regional centres for space science and technology education in existing national or regional educational institutions in developing countries, as outlined in the report of the Expert on Space Applications.

41. The Subcommittee noted with appreciation the offers by a number of Member States to host such regional centres and indications of support and participation from other Member States. The Subcommittee noted that evaluation missions concerning the establishment of such regional centres had been carried out in all developing regions. The Subcommittee further noted that each centre would continue expanding and would become part of a network with subsidiary nodes to cover specific programme elements in established institutions related to space technology in each region.

42. The Subcommittee noted that arrangements for the establishment of a centre in Brazil and in Mexico are being undertaken and that Brazil and Mexico had reaffirmed their commitment to the prompt establishment of a centre for the Latin American and Caribbean region and expressed their view that effective

coordination and cooperation within the Secretariat units involved in this matter and between those countries and the Secretariat would be crucial to achieving this goal. The Subcommittee also noted the support of other Latin American countries for the early establishment and operation of the centre.

43. The delegations of Argentina and Chile also expressed the will of their Governments to participate actively in the work and activities of the centre in the Latin American and Caribbean region, and their intention of being members of the Board of Governors for that centre.

44. The Subcommittee noted that, following an evaluation mission, the Office for Outer Space Affairs made the decision that the centre in the Asia and Pacific region would be established in India and that it would subsequently grow as a network institution with major nodes to cover specific programme elements in established institutions related to space technology in the region.

45. With regard to the centre in the Asia and Pacific region, India reaffirmed its commitment to establish the Centre as soon as possible and expressed the hope that, with the participation and support of the United Nations and the countries in the region, the centre would grow, and reported that a planning meeting had been held at Bangalore, India, on 24 and 25 January 1995, to which representatives of countries in the region that had offered to host the centre had been invited, as were other developing countries in the region with significant space activities. In addition, the representatives of the Secretariat of the United Nations and of the Economic and Social Commission for Asia and the Pacific (ESCAP) participated in the meeting. It was also reported that the meeting discussed the steps planned for starting the centre and considered a draft agreement that would be circulated to all countries of the region.

46. The view was expressed that the process that had been utilized in the selection of the host country for the regional Centre for Space Science and Technology Education in the Asia and Pacific region was flawed because it was inconsistent with the principle of democratic consultation and that, although the Office for Outer Space Affairs was aware of the different views of Member States on this matter, the selection had not been based on consultations among Member States of the region nor on the consensus agreement of Member States of the region that are members of the Committee. The view was also expressed that the procedure utilized for the selection of the host country would affect whether or not the centre could smoothly carry out its mission.

47. Some delegations expressed the view that information on the establishment of the centres, including a review of the status of ongoing negotiations and programmes proposed for them, should be provided to all interested delegations on a continuous basis, possibly through the convening, by the United Nations, of regular meetings of all interested countries within a region.

48. In response to the concerns expressed by Member States with regard to the centres in the Latin American and Caribbean and the Asia and Pacific regions, the Expert on Space applications made a statement clarifying the procedures used in the selection process of host countries and the Secretariat provided Member States with the text of a draft agreement for the establishment of those centres containing the general obligations to be undertaken by the United Nations in that regard.

49. It was further noted that discussions on the establishment of a centre for the Economic Cooperation Organization (ECO) are in progress with the Government of the Islamic Republic of Iran. With regard to a centre for the region covered by the Economic Commission for Africa (ECA), the Subcommittee noted that an evaluation mission had been undertaken to the countries that had offered to host the centre in that region. As one of those countries visited by the mission, Morocco reaffirmed its offer to host the centre for Africa and requested additional information on the status of the process for establishment of that centre as well as information on possible funding sources. It was also noted that the Syrian Arab Republic had reaffirmed its offer to host the centre for the region covered by the Economic and Social Commission for Western

Asia (ESCWA) at its National Centre for Remote Sensing and had reported on recent discussions it has had to that end with various United Nations entities.

50. The Subcommittee noted with satisfaction that the Ministerial Conference on Space Applications for Development in Asia and the Pacific Region and its Preparatory Meeting of Senior Officials were organized by ESCAP and hosted by the Government of China, from 19 to 24 September 1994, in Beijing. The Subcommittee also took note of the Beijing Declaration on Space Technology Applications for Environmentally Sound and Sustainable Development in Asia and the Pacific, adopted by the Conference, as well as the Strategy for Regional Cooperation in Space Applications for Sustainable Development and the Action Plan on Space Applications for Sustainable Development in Asia and the Pacific.

51. The Subcommittee noted the establishment, in October 1994, of the Asia-Pacific Satellite Communication Council (APSCC) to serve as a regional forum to promote exchanges and cooperation in the field of satellite communications and broadcasting.

52. The Subcommittee noted the contributions made by specialized agencies and other international organizations towards the promotion of international cooperation in space activities: FAO was continuing its activities relating to the remote sensing of renewable natural resources and environmental monitoring, including training courses and the support of development projects; ITU was continuing its work in the international coordination of space communications, including providing technical assistance to developing countries; WMO was continuing international cooperative programmes using space technology, including the World Weather Watch and the Tropical Cyclone Programme; UNESCO was promoting applications to space technology for archaeology, and strengthening international and interdisciplinary cooperation between archaeological projects; UNIDO was continuing its work on spin-off benefits of space technology; International Maritime Satellite Organization (INMARSAT) was continuing to develop its satellite communication system for maritime, aeronautical and land-mobile communications, including the development of small, low-cost terminals and the provision of technical assistance and training; International Telecommunications Satellite Organization (INTELSAT) was further developing its system for international satellite communications and broadcasting, including its programmes for training and technical assistance; ESA was continuing its programme of international cooperative space activities, including training programmes for the benefit of developing countries, support of the activities of the United Nations Programme on Space Applications and technical assistance projects; ICAO was continuing its work towards implementation of communications, navigation and surveillance/air traffic management (CNS/ATM) systems.

53. The Subcommittee emphasized the importance of regional and international cooperation in making the benefits of space technology available to all countries by such cooperative activities as shared payloads, dissemination of information on spin-off benefits, ensuring compatibility of space systems and providing access to launch capabilities at reasonable cost.

## III. MATTERS RELATING TO REMOTE SENSING OF THE EARTH BY SATELLITES INCLUDING, INTER ALIA, APPLICATIONS FOR DEVELOPING COUNTRIES

54. In accordance with General Assembly resolution 49/34, paragraph 13 (a)(iii), the Subcommittee continued its consideration of the item relating to remote sensing of the Earth.

55. In the course of the debate, delegations reviewed the national and cooperative programmes in remote sensing. Examples were given of national programmes in developing and developed countries and of international programmes based on bilateral, regional and international cooperation, including programmes of technical cooperation between developing countries. Countries with advanced capabilities in the field, including some developing countries, described programmes to provide assistance to developing countries.

56. The Subcommittee took note of the continuing programmes of Argentina, Australia, Brazil, China, France, Germany, India, Indonesia, Japan, Morocco, Russian Federation, Ukraine, United States and ESA for remote sensing satellites. The Subcommittee noted that the launches of the European Remote Sensing (ERS-1) satellite and the Japanese Earth Resources Satellite (JERS-1) would provide valuable microwave data to complement the multispectral data from satellites of the Landsat, Resurs, SPOT, Indian Remote Sensing (IRS) and Marine Observation Satellite (MOS) series. The Subcommittee also noted the remote sensing systems being developed for future launch, including the SAC-C of Argentina, RADARSAT of Canada, FY-2 of China, IRS-1C and IRS-P3 of India, ADEOS-1 and TRMM of Japan, various systems of the Russian Federation and the ERS-II satellite of ESA. It also took note of the activities of FAO in remote sensing of renewable natural resources, including land-cover mapping and geographic information systems, of the work of WMO in the areas of weather forecasting and storm warning and of ISPRS in promoting international cooperation in remote sensing and image processing. The Subcommittee heard a scientific and technical presentation on the remote sensing activities of France, as described in paragraph 16 of the present report.

57. The Subcommittee reiterated its view that remote-sensing activities should take into account the need to provide appropriate and non-discriminatory assistance to meet the needs of the developing countries.

58. The Subcommittee emphasized the importance of making remote sensing data and analysed information openly available to all countries at reasonable cost and in a timely manner. The Subcommittee also recognized the need for continuing free access to data from operational meteorological satellites.

59. The Subcommittee considered that international cooperation in the use of remote sensing satellites should be encouraged, both through coordination of the operations of ground stations and through regular meetings between satellite operators and users. It noted the importance of compatibility and complementarity of existing and future remote sensing systems as well as the need for continuity in the acquisition of data. The Subcommittee also noted the importance, particularly for the developing countries, of sharing experiences and technologies, of cooperation through international and regional remote sensing centres and of joint work on collaborative projects. The Subcommittee also noted the value of remote sensing systems for environmental monitoring and, in that context, stressed the need for the international community to utilize fully remote sensing data in an effort to implement fully the recommendations contained in Agenda 21[1] of the United Nations Conference on Environment and Development (UNCED) in Brazil in 1992.

60. Recalling General Assembly resolution 41/65, annex, of 3 December 1986, by which the Assembly had adopted the Principles Relating to Remote Sensing of the Earth from Outer Space, the Subcommittee recommended that at its thirty-third session it should continue its discussion on remote sensing activities conducted in accordance with those Principles during its consideration of the agenda item concerning remote sensing.

61. The view was expressed that the international community should organize, on an annual basis, an International Space Day, which would be celebrated through special events, such as symposia, conferences and technical meetings, in all countries.

62. The Subcommittee recommended that the item should be retained on its agenda as a priority item for the next session.

## IV. USE OF NUCLEAR POWER SOURCES IN OUTER SPACE

63. In accordance with General Assembly resolution 49/34, paragraph 13 (a)(iv), the Subcommittee continued its consideration of the item relating to the use of nuclear power sources in outer space.

64. The Subcommittee recalled that the General Assembly had adopted the Principles Relevant to the Use of Nuclear Power Sources in Outer Space, as contained in its resolution 47/68 of 14 December 1992. While noting that the Principles provided that they should be reopened for review and revision by the Committee no later than two years after their adoption, the Subcommittee also recalled that at its last session, the Committee agreed (A/49/20, para. 68) that the Principles should remain in their current form until amended and that before amendment, proper consideration should be given to the aims and objectives of any proposed revision.

65. The Subcommittee agreed that, at the present time, revision of the Principles was not warranted.

66. The Subcommittee agreed that regular discussions on this issue should continue at future sessions and that the Subcommittee and the Working Group on nuclear power sources should continue to receive the widest input on matters affecting the use of nuclear power sources in outer space and any contribution related to improving the scope and application of the Principles.

67. The Subcommittee noted the statement made by IAEA drawing attention to recent developments in nuclear safety, particularly the joint FAO/IAEA/ILO/OECD-NEA/PAHO new International Basic Safety Standards for Protection against Ionising Radiation and for the Safety of Radiation Sources, and the new document on Emergency Planning and Preparedness for Nuclear Powered Satellite Re-Entry, due to be published in 1995.

68. Mindful of the differences in the application of safety standards to space and terrestrial systems, the Subcommittee agreed that the study of these developments, arising from the latest International Commission on Radiological Protection (ICRP) recommendations, should be continued.

69. Some delegations expressed the view that a net positive benefit should be demonstrated from the use of nuclear power sources in outer space and that this principle of justification could be satisfied on a global scale.

70. The view was expressed that the Scientific and Technical Subcommittee, at future sessions, could examine the technical aspects of the utilization of nuclear power sources for missions to the Moon and other celestial bodies.

71. In accordance with General Assembly resolution 49/34, the Working Group on the Use of Nuclear Power Sources in Outer Space was reconvened on 13 February under the chairmanship of Professor J. H. Carver (Australia). No further work was undertaken in the Working Group at this session.

72. The Subcommittee noted that in response to its recommendation, the General Assembly, in resolution 49/34, paragraph 17, had invited Member States to report to the Secretary-General on a regular basis with regard to national and international research concerning the safety of nuclear-powered satellites. The Subcommittee also noted that the General Assembly, in paragraph 32 of the same resolution, had considered that, to the extent possible, information on the problem of collisions of space objects, including those with nuclear power sources, with space debris should be provided to the Scientific and Technical Subcommittee in order to allow it to follow that area more closely. The Subcommittee noted that information had been submitted in response to those requests, as contained in document A/AC.105/593 and annex and Add.1, 2, 3 and 4 by Belgium, Canada, France, Germany, Hungary, Japan, Malta, Poland, Russian Federation, Sri

Lanka and United Kingdom as well as IAEA, International Academy of Astronautics (IAA), COSPAR and INTELSAT, contained in document A/AC.105/593. The Subcommittee heard scientific and technical presentations on the topic of nuclear power sources by the Russian Federation and the United Kingdom, as described in paragraph 16 of the present report.

73. The Subcommittee agreed that Member States should continue to be invited to report to the Secretary-General on a regular basis with regard to national and international research concerning the safety of orbiting space objects with nuclear power sources. The Subcommittee also agreed that further studies should be conducted on the issue of the collision of orbiting space objects with nuclear power sources on board with space debris and that it should be kept informed of the results of such studies.

74. The Subcommittee recommended that the item be retained on its agenda for the next session, and that the time allocated to the topic in both the Working Group and the Subcommittee should be adjusted as appropriate.

## V. SPACE DEBRIS

75. In accordance with resolution 49/34, the Subcommittee continued its consideration, on a priority basis, of the agenda item on space debris, including relevant studies, mathematical modelling and other analytical work on the characterization of the space debris environment.

76. The Subcommittee recalled that during its thirty-first session it had agreed that at the next session it should focus its attention on the subject of the acquisition and understanding of data on the characteristics of the space debris environment, with a view to establishing a common understanding that could serve as the basis for its further deliberations. Some delegations expressed the view that the above subject was not given sufficient focus during the present session and needed further consideration.

77. The Subcommittee expressed its satisfaction at having the subject of space debris as a priority agenda item and agreed that consideration of space debris was important and that international cooperation was needed to expand appropriate and affordable strategies to minimize the potential impact of space debris on future space missions.

78. In accordance with resolution 49/34, paragraph 12, the Subcommittee focused its attention on the acquisition and understanding of data on the characteristics of the space debris environment.

79. The Subcommittee agreed that it was important to have a firm scientific and technical basis for future action on the complex attributes of space debris and that the Subcommittee should, inter alia, focus on understanding aspects of research related to space debris, including debris measurement techniques; mathematical modelling of the debris environment; characterizing the space debris environment; and measures to mitigate the risks of space debris, including spacecraft design measures to protect against space debris.

80. The Subcommittee agreed that it could be desirable to compile information on various steps taken by space agencies for reducing the growth or damage potential of space debris and to encourage common acceptance by the international community, on a voluntary basis.

81. The Subcommittee took note of the following programmes of Member States and organizations on the acquisition and understanding of data on the characteristics of the space debris environment, and on measuring, modelling and mitigating the orbital debris environment. These programmes include the Long Duration Exposure Facility (LDEF), Material Exposure in Low Earth Orbit (MELEO) and Advanced Composite Material Exposure Experiment (ACOMEX) experiments of Canada; the Tracking and Image Radar Station (TIRA) of Germany; the Haystack Orbital Debris Radar, the Orbital Debris Radar Calibration

Spheres (ODERACS-1 and 2), the Charged Couple Device (CCD) Debris telescope, the Liquid Metal Mirror Telescope (LMMT) of the United States; the Communication Research Laboratory (CRL) and Middle and Upper Atmosphere (MU) radar system of Japan; the various monitoring facilities and analytical models established by the Russian Federation; and the Space Debris Reference Model (MASTER) of ESA .

82. The Subcommittee noted that the Interagency Orbital Debris Coordination Committee (IADC), with the participation of NASA, ESA, STA/NASDA and the Russian Space Agency (RSA), had been formed in 1993 to enable its members to exchange information on space debris activities, facilitate opportunities for cooperation in space debris research, review the progress of ongoing activities and identify debris mitigation options.

83. In order to advance in its consideration of space debris, the following work plan was adopted by the Subcommittee:

1996: Measurements of space debris, understanding of data and effects of this environment on space systems

Measurements of space debris comprise all processes by which information on the near-Earth particulate environment is gained through ground- and space-based sensors. The effect (impact of particulates and resulting damage) of this environment on space systems should be described.

1997: Modelling of space debris environment and risk assessment

A space debris model is a mathematical description of the current and future distribution in space of debris as a function of its size and other physical parameters. Aspects to be addressed are:

- Analysis of fragmentation models
- Short- and long-term evolution of the space debris population
- Comparison of models.

The various methods for collision risk assessment should be critically reviewed.

1998: Space debris mitigation measures

Mitigation comprises reduction of the space debris population growth and protection against particulate impact. Measures for the reduction of space debris growth include methods for debris prevention and removal. Protection against space debris includes:

- Physical protection with shielding
- Protection through collision avoidance.

Each session should review the current operational debris mitigation practices and consider future mitigation methods with regard to cost efficiency.

84. The Subcommittee agreed that the work plan should be implemented with flexibility and agreed that, notwithstanding the selection of a specific topic for the next session, delegations wishing to address the Subcommittee at that time on other aspects of scientific research related to space debris should be free to do so.

85. In accordance with General Assembly resolution 49/34, paragraph 32, the Subcommittee agreed that Member States should pay more attention to the problem of collisions of space objects, including those with

nuclear power sources on board, with space debris, and other aspects of space debris. It noted that the Assembly, in the same resolution, had called for the continuation of national research on that question for the development of improved technology for the monitoring of space debris and for the compilation and dissemination of data on space debris. The Subcommittee recalled the request of the Assembly that information on those issues should be submitted to the Scientific and Technical Subcommittee and took note of the reports submitted to it in accordance with that request contained in documents A/AC.105/593 and Add.1, 2, 3 and 4. The Subcommittee further agreed that national research on space debris should continue and that Member States should make the results of that research available to all interested parties.

86. The Subcommittee took note of the informal working paper submitted on space debris by the United Kingdom as well as the national reports submitted and contained in document A/AC.105/593 and Add.1, 2, 3 and 4.

87. The Subcommittee heard scientific and technical presentations on the subject of space debris by France, India, Poland, United Kingdom and ESA, as mentioned in paragraph 15 of the present report.

88. The Subcommittee noted that a certain amount of research on space debris had already been undertaken in some countries, which had allowed for a better understanding of the sources of debris, the areas in near-Earth orbit that were reaching high levels of space debris density, the probabilities and effects of collisions and the necessity of minimizing the creation of space debris. The Subcommittee encouraged Member States and relevant international organizations to provide information on practices that they had adopted and that had proven effective in minimizing the creation of space debris.

89. Some delegations were of the view that the Legal Subcommittee should be informed of the discussions in the Scientific and Technical Subcommittee on that agenda item. The view was also expressed that a set of international rules for the launch of spacecraft should be codified, based on current practices of space agencies, in order to reduce the growth of orbital debris.

90. Other delegations expressed the view that it would not be appropriate to discuss the issue of space debris in the Legal Subcommittee or to develop recommendations in the Scientific and Technical Subcommittee to underpin new legal norms for orbital debris in view of the many technical issues that still need to be discussed by the Scientific and Technical Subcommittee .

91. Some delegations expressed the view that the primary focus of the Subcommittee in dealing with this item should be on international cooperation, while the aim of improving the understanding of scientific and technical progress is pursued in its deliberations.

92. Some delegations expressed the view that data relating to space debris including size, mass and orbital elements should be accessible to all interested researchers worldwide. It was suggested that, in this context, international data networks could be used to provide such access on an open and timely basis.

93. Some delegations expressed the view that a clear goal of its work on space debris was to arrive at a set of cooperative actions and technically feasible measures to deal with the problem of debris in orbit around the Earth. Establishing a sound scientific and technical rationale for these should be integral to this objective.

94. Some delegations expressed the view that open access to research data and to a standard model for consistency in analysis and results should be available for all countries.

95. The view was expressed that the Subcommittee should establish a working group to discuss space debris and that it was important for the Subcommittee to have a common understanding of the term "space debris". In this regard, it was proposed that the Subcommittee should adopt the following explanation of the term:

Space debris are all man-made objects, including their fragments and parts, in Earth orbit or re-entering the dense layers of the atmosphere that are non-functional with no reasonable expectation of their being able to assume or resume their intended functions or any other functions for which they are or can be authorized.

96. The Subcommittee recommended that the item be retained on its agenda as a priority item for its next session.

## VI. QUESTIONS RELATING TO SPACE TRANSPORTATION SYSTEMS AND THEIR IMPLICATIONS FOR FUTURE ACTIVITIES IN SPACE

97. In accordance with General Assembly resolution 49/34, the Subcommittee continued its consideration of the item relating to space transportation systems.

98. In the course of the discussion, delegations reviewed national and international cooperative programmes in space transportation systems, including expendable launchers, reusable space shuttles and space stations. In particular, the Committee noted that China was continuing the use and development of its Long March series of launch vehicles; that India was continuing development of the Geostationary Satellite Launch Vehicle and had succeeded in the developmental launches of the Augmented Satellite Launch Vehicle and the Polar Satellite Launch Vehicle; that Japan had successfully launched the H-II launch vehicle and was continuing its development of the J-I and M-V launch vehicles; that the Russian Federation had launched space objects of various types using expendable launchers of the Soyuz, Cosmos, Proton and other series, and had sent a number of national and international crews to the Mir space station; that Ukraine was continuing to produce, successfully use and improve the Tsyklon and Zenit rocket launchers; that the United Kingdom was cooperating with the Russian Federation and Ukraine on the concept of the reusable interim HOTOL system and with ESA in its Future European Space Transportation Investigation Programme (FESTIP); that the United States was continuing its programme of expendable launches and flights of the reusable Space Shuttle and was developing the International Space Station in cooperation with Canada, Japan, the Russian Federation and ESA; and that ESA was continuing development of the Ariane series of launch vehicles.

99. The Subcommittee took note of developments in low-cost microsatellite technology and applications that could allow more countries to take an active part in space activities.

100. The Subcommittee stressed the importance of international cooperation in space transportation in order to provide all countries with access to the benefits of space science and technology.

101. The Subcommittee recommended that consideration of the item be continued at its next session.

## VII. EXAMINATION OF THE PHYSICAL NATURE AND TECHNICAL ATTRIBUTES OF THE GEOSTATIONARY ORBIT; EXAMINATION OF ITS UTILIZATION AND APPLICATIONS, INCLUDING, INTER ALIA, IN THE FIELD OF SPACE COMMUNICATIONS, AS WELL AS OTHER QUESTIONS RELATING TO SPACE COMMUNICATIONS DEVELOPMENTS, TAKING PARTICULAR ACCOUNT OF THE NEEDS AND INTERESTS OF DEVELOPING COUNTRIES

102. In accordance with General Assembly resolution 49/34, the Subcommittee continued its consideration of the item relating to the geostationary orbit and space communications. The Subcommittee heard a special presentation on matters related to the agenda item by the expert from ITU, as mentioned in paragraph 16 of the present report.

103. In the course of the discussion, delegations reviewed national and international cooperative programmes in satellite communications, including progress in communications satellite technology that would make satellite communications more accessible and less expensive and increase the communications capacity of the geostationary orbit and the electromagnetic spectrum.

104. The Subcommittee took note of the growing use of communications satellite systems for telecommunications, television broadcasting, data networks, environmental data relay, mobile communications, disaster warning and relief, telemedicine and other communications functions.

105. Some delegations expressed the view that the geostationary orbit was a limited natural resource and that saturation should be avoided in order to ensure that all countries had non-discriminatory access to the orbit. Those delegations felt that a special sui generis legal regime was required to ensure equitable access by all States, particularly developing countries. They felt that the role of ITU, which concerned the technical aspects, and of the Committee on the Peaceful Uses of Outer Space with respect to the geostationary orbit were complementary. Other delegations expressed the view that questions relating to the geostationary orbit were being addressed effectively by ITU.

106. Some delegations expressed the view that in considering the question of equitable access, account should be taken in particular of the characteristics of the equatorial countries. The view was expressed that a definition of the geostationary orbit, as proposed in working paper A/AC.105/C.2/L.192 of 30 March 1993, should be revised to be in line with the definition used by ITU.

107. Some delegations noted that the use of the geostationary orbit, like other orbits, was affected by the problem of space debris and that efforts were needed to minimize the generation of debris in the orbit and to move satellites shortly before the end of their useful lives into disposal orbits beyond the geostationary orbit.

108. The Subcommittee recommended that consideration of the item relating to the geostationary orbit and space communications be continued at its next session.

## VIII. PROGRESS IN NATIONAL AND INTERNATIONAL SPACE ACTIVITIES RELATED TO THE EARTH ENVIRONMENT, IN PARTICULAR PROGRESS IN THE GEOSPHERE-BIOSPHERE (GLOBAL CHANGE) PROGRAMME

109. In accordance with General Assembly resolution 49/34, the Subcommittee continued its consideration of the item concerning progress in national and international space activities related to the Earth environment, in particular progress in the Global Change Programme. The Subcommittee heard a special presentation on matters related to the agenda item by an expert from France, as mentioned in paragraph 16 of the present report.

110. The Subcommittee noted the progress being made through international cooperation in the Global Change Programme, with the participation of many countries. It noted that such a joint international effort was of fundamental importance for examining the future habitability of the planet and for managing the common natural resources of the Earth. The Subcommittee took particular note of the need to involve as many countries as possible in the scientific activities of the Programme, both in developed and in developing countries.

111. The Subcommittee took note of the important contributions of satellite remote sensing for environmental monitoring, for planning sustainable development, for water-resource development, for monitoring crop conditions, and for predicting and assessing drought.

112. The Subcommittee noted the important contribution of meteorological and atmospheric research satellites for studying global climate change, the greenhouse effect, the degradation of the ozone layer and other global environmental processes. The previously launched Topex/Poseidon oceanographic satellite, Upper Atmosphere Research Satellite, Total Ozone Mapping System, CRISTA-SPAS, third Atmospheric Laboratory for Applications and Science (ATLAS-3) and Lidar in Space Technology Experiment (LITE) were important tools for that purpose, as would be the planned Phase II Mission to Planet Earth, Earth Observing System (EOS) series of spacecraft, Envisat, the IRS series of spacecraft, ADEOS, Meteor and other similar spacecraft. The Subcommittee noted the need for further space research relating to climate change, weather patterns, vegetation distribution, storm and flood risk, and other environmental factors.

113. The Subcommittee noted the importance of international cooperation in the various existing and planned satellite systems for environmental monitoring. It recommended that other States consider participating in such cooperative activities.

114. The Subcommittee recommended that consideration of the item be continued at its next session.

## IX. MATTERS RELATING TO LIFE SCIENCES, INCLUDING SPACE MEDICINE

115. In accordance with General Assembly resolution 49/34, the Subcommittee continued its consideration of the item relating to life sciences.

116. The Subcommittee recalled that the General Assembly, in its resolution 49/34, had considered it particularly important that all countries should have the opportunity to use the techniques resulting from medical studies in space.

117. The Subcommittee noted that studies of human and animal physiology under the microgravity conditions of space flight had led to important advances in medical knowledge in such areas as blood circulation, sensory perception, immunology and the effects of cosmic radiation. It noted that important new information in those fields had been obtained through experiments on the Mir space station, particularly during the joint ESA-Russian Federation mission, which had utilized equipment provided by Austria, Bulgaria, France and Germany; the United States Space Shuttle mission of the International Microgravity Laboratory, including experiments from Canada, France, Germany, Japan and ESA; STS 63 mission of the United States Space Shuttle including a cosmonaut from the Russian Federation; and the recoverable scientific experiment satellites of China. The Subcommittee heard a special presentation by the expert from the Austrian Society for Aerospace Medicine, as described in paragraph 16 of the present report.

118. The Subcommittee noted that applications of space technologies were demonstrating growing promise in medicine and public health on Earth. Satellite communications for telemedicine were providing expert medical advice to distant areas, as illustrated by the Telemedicine Spacebridge to Moscow linking medical centres in the United States and the Russian Federation. The Subcommittee also noted that products of space biotechnology, such as pharmaceutical and medical instruments, could contribute to improved health care. The Subcommittee noted the importance of space technology for those purposes and encouraged further research and exchange of information on those applications.

119. The Subcommittee noted that space studies in life sciences and medicine had important potential benefits for all countries and that efforts should be made to promote international cooperation to enable all countries to benefit from those advances.

120. The Subcommittee recommended that consideration of the item be continued at its next session.

## X. MATTERS RELATING TO PLANETARY EXPLORATION AND MATTERS RELATING TO ASTRONOMY

121. In accordance with General Assembly resolution 49/34, the Subcommittee continued its consideration of the item on planetary exploration and the item on astronomy.

122. The Subcommittee noted that several planetary exploration missions were currently under way. The Magellan spacecraft had completed its systematic radar and gravity field mapping programme of Venus and had provided unique information during its aerobraking experiments in the dense Venus atmosphere. The Galileo spacecraft, on its way to Jupiter, had produced high-resolution images of asteroid 243 Ida and discovered its tiny satellite Dactyl. The ESA Ulysses spacecraft, following its swing-by trajectory from Jupiter, was studying the solar polar regions that had not been previously investigated. The Subcommittee noted plans for missions planned for future launch, including Mars 94 and 96, Mars Surveyor and Pathfinder, for investigation of Mars; Cassini/Huygens, for investigation of Saturn and its moons; and the Near-Earth Asteroid Rendezvous (NEAR) and Rosetta missions. The Subcommittee heard a special presentation by Austria on Austrian experience in planetary research, as described in paragraph 16 of the present report. The Subcommittee noted the high degree of international cooperation in all of those investigations and stressed the need to further enhance international cooperation in planetary exploration to enable all countries to benefit from and participate in those activities.

123. The Subcommittee noted that the use of spacecraft for making astronomical observations from above the atmosphere had greatly advanced knowledge of the universe by allowing observations in all regions of the electromagnetic spectrum. It noted that with the repaired Hubble Space Telescope, Rosat, Granat and Roentgen-Kvant X-ray observatories, Compton Gamma Ray Observatory, Extreme Ultraviolet Explorer, Astro-D, Freja Koronas I and Wind satellites, and with data from the recent Stretched Rohini Scientific Satellite (SROSS C-2) as well as ORFEUS-SPAS and Spartan subsatellites, astronomers had powerful tools for their investigations of the universe. The planned launches of the Radioastron satellite, Spektr-Roentgen-Gamma observatory, Infrared Space Observatory, Advanced X-ray Astrophysics Facility, Space Infrared Telescope Facility, Spektr-UV, Relict-2, Scientific Applications Satellite (SAC-B) and X-ray Multi-Mirror Mission (XMM) would open up further realms of the universe to detailed observation. The Subcommittee noted with satisfaction that all of those projects were open to broad international cooperation. The Subcommittee also heard a special presentation by IAU on adverse environmental impacts on astronomy with special reference to the severe impact of electromagnetic pollution on radio astronomy and the effects of space debris on astronomical observations particularly at optical wavelengths.

124. The Subcommittee recommended that consideration of the items be continued at its next session.

## XI. THE THEME FIXED FOR SPECIAL ATTENTION AT THE 1995 SESSION: APPLICATION OF SPACE TECHNOLOGY FOR EDUCATION, WITH PARTICULAR EMPHASIS ON ITS USE IN DEVELOPING COUNTRIES

125. In accordance with General Assembly resolution 49/34, the Subcommittee paid special attention to the theme "Application of space technology for education, with particular emphasis on its use in developing countries". The Subcommittee noted with satisfaction that, at its invitation, COSPAR and IAF had organized a symposium on the theme on 6 and 7 February 1995, as described in paragraphs 13 and 14 of the present report.

126. The Subcommittee also heard special presentations on the special theme by Canada and the Russian Federation, as well as by the International Space University and the Globe Foundation, as described in paragraph 16 of the present report.

127. The Subcommittee took note of the important contributions that space technology could make in the field of education. Recent dramatic increase of the volume of knowledge is leading to the necessity of correspondingly adjusting learning procedures for children and adults as well. Space education is usually defined as a method of education, which takes into account human existence being included in space as environment. This means that it is not limited only to the use of space technology - such as communication satellites - for education, but it should lead to a more complex understanding of the place and role of humankind in its global environment. It was also noted that space education should not be performed solely by space agencies or similar national or international organizations, but rather in close cooperation with relevant educational institutions.

128. The Subcommittee also noted that invaluable experience with new educational methods, including space education, has been obtained by many Member States and national and international organizations and that appropriate use of this experience could substantially improve learning procedures, particularly in developing countries. It was also noted that the Eurisy workshop "Distance learning and environmental awareness: the role of satellites", held at ESRIN (Frascati, Italy) in September 1994, provided some interesting conclusions and recommendations in this respect.

## XII. OTHER MATTERS

### A. Third UNISPACE conference

129. The Subcommittee noted that the General Assembly, in its resolution 49/34, paragraph 26, had agreed that the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space could be convened in the near future and had also agreed that, prior to recommending a date for the Conference, there should be a consensus recommendation on the agenda, venue and funding of the Conference. The General Assembly further recommended that the Scientific and Technical Subcommittee should continue its examination of other means for achieving the goals set for such a conference. The Subcommittee also noted the agreement of the General Assembly, in paragraph 29 of the same resolution, that the discussions to be held by the Subcommittee should provide the basis for a prompt decision by the Committee on a recommendation to the Assembly regarding the agenda, timing, funding and organization of such a conference.

130. The Subcommittee noted with satisfaction that in accordance with its recommendation, the Secretariat had prepared in time for consideration by the Committee at its last session a comprehensive report on the likely organization, funding and logistical implications of holding such a conference, including an analysis of UNISPACE 82, its organization, funding and logistics, as well as an analysis of various combinations of duration, scope and venue for a third UNISPACE conference (A/AC.105/575). The Subcommittee also noted with appreciation that following a request of the Committee, the Secretariat had compiled, in time for consideration by the Subcommittee, a document which contained the various ideas regarding the agenda and organization of the third UNISPACE conference submitted to the Committee (A/AC.105/575/Add.1).

131. The Subcommittee, through its Working Group of the Whole, carried out the tasks entrusted to it by the General Assembly in resolution 49/34, paragraph 27. The Subcommittee, in adopting the report of the Working Group, noted the views of the Working Group of the Whole as outlined in its report, contained in annex II to the present report. In adopting the report, the Subcommittee agreed that the report of the Working

Group should provide the basis for continued discussions by the Committee on a recommendation to the General Assembly as envisaged in resolution 49/34.

## B. Other reports

132. The Subcommittee welcomed the annual reports of WMO (A/AC.105/597), EUTELSAT (A/AC.105/598), INTELSAT (A/AC.105/599), EUMETSAT (A/AC.105/600), ITU (A/AC.105/603) and ISPRS (A/AC.105/604). The Subcommittee requested those organizations to continue to report on their work.

133. The Subcommittee expressed its appreciation to COSPAR for its report on the progress of space research and to IAF for its report on space technology and applications published jointly under the title "Highlights in space: Progress in space science, technology and applications, international cooperation and space law, 1994" (A/AC.105/583).

134. The Subcommittee noted with appreciation the participation in its session of representatives from United Nations bodies, specialized agencies and permanent observers, and found their statements and reports helpful in enabling the Subcommittee to fulfil its role as focal point for international cooperation in space.

## C. Review of the future role and work of the Scientific and Technical Subcommittee

135. The Subcommittee recommended that the agenda of its thirty-third session should include the following priority items:

(a) Consideration of the Programme on Space Applications and the coordination of space activities within the United Nations system;

(b) Implementation of the recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82);

(c) Matters relating to remote sensing of the Earth by satellites including, inter alia, applications for developing countries;

(d) Use of nuclear power sources in outer space;

(e) Space debris.

136. The Subcommittee recommended that the agenda of its thirty-third session should also include the following items:

(a) Questions relating to space transportation systems and their implications for future activities in space;

(b) Examination of the physical nature and technical attributes of the geostationary orbit; examination of its utilization and applications, including, inter alia, in the field of space communications, as well as other questions relating to space communications developments, taking particular account of the needs and interests of developing countries;

(c) Matters relating to life sciences, including space medicine;

(d) Progress in national and international space activities related to the Earth environment, in particular progress in the International Geosphere-Biosphere (Global Change) Programme;

(e) Matters relating to planetary exploration;

(f) Matters relating to astronomy;

(g) Consideration of the theme fixed for special attention at the thirty-third session of the Scientific and Technical Subcommittee: "Utilization of micro- and small satellites for the expansion of low-cost space activities, taking into account the special needs of developing countries".

137. The Subcommittee recommended that, regarding agenda item (g) in paragraph 136 above, COSPAR and IAF, in liaison with Member States, should be invited to arrange a symposium, with as wide a participation as possible, to be held during the first week of the thirty-third session, to complement discussions by the Subcommittee on the special theme.

138. The Subcommittee, during its general exchange of views, discussed the possibility of having a more streamlined and focused agenda in the future and agreed that these discussions should be continued at its next session and considered when the provisional agenda was being drawn up.

139. With regard to the dates for the thirty-third session, the Subcommittee recommended that it be scheduled from 12 to 23 February 1996.

### D. Tribute

140. The Subcommittee expressed its appreciation to the Chairman, Professor John H. Carver of Australia, who announced he would be retiring after the current session after having served as Chairman of the Subcommittee for 25 years. The Subcommittee noted that during his tenure, Professor Carver had made a significant and lasting contribution to the promotion of international cooperation in the peaceful uses of outer space, and wished him well in his future pursuits. At the 464th meeting of the Subcommittee on 16 February 1995, Professor Carver was presented with a testimonial letter from the Secretary-General of the United Nations thanking him for his 25 years of dedicated service to the international community.

### Notes

[1] Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992 (United Nations publication, Sales No. E.93.I.8 and corrigenda), vol. I: Resolutions Adopted by the Conference, resolution 1, annex II.

## Annex I

## DOCUMENTS BEFORE THE SCIENTIFIC AND TECHNICAL SUBCOMMITTEE AT ITS THIRTY-SECOND SESSION

### Item 1 - Adoption of the agenda

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| A/AC.105/C.1/L.200 | Provisional agenda, with annotations, for the thirty-second session |

### Item 4 - United Nations Programme on Space Applications and the coordination of space activities within the United Nations system

### Item 5 - Implementation of the recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space

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| A/AC.105/556/Add.1 | Report on the United Nations/European Space Agency Training Course for African Francophone Countries on Applications of the European Remote Sensing Satellite (ERS-1) Data for Natural Resources, Renewable Energy and the Environment (Frascati, Italy, 19-30 April 1993) |
| A/AC.105/580 | Report on the Fourth United Nations/European Space Agency Workshop on Basic Space Science, hosted by the Government of Egypt (Cairo, Egypt, 27 June-1 July 1994) |
| A/AC.105/581 | Report on the Fourth United Nations Training Course on Remote Sensing Education for Educators, held in cooperation with the Government of Sweden (Stockholm and Kiruna, Sweden, 2 May-10 June 1994) |
| A/AC.105/582 | Report of the Ad Hoc Inter-Agency Meeting on Outer Space Activities (United Nations Office at Vienna, 3-5 October 1994) |
| A/AC.105/584 | Seminars of the United Nations Programme on Space Applications: Selected papers on remote sensing, satellite communications and space science, 1995 |
| A/AC.105/586 | Report on the United Nations Workshop on Enhancing Social, Economic and Environmental Security through Space Technology, hosted by the Government of Austria (Graz, Austria, 12-15 September 1994) |
| A/AC.105/587 | Coordination of outer space activities within the United Nations system: Programmes of work for 1995 and 1996 and future years |
| A/AC.105/588 | Report on the United Nations/European Space Agency Workshop on Microwave Remote Sensing Applications, hosted by the Government of China (Beijing, China, 14-18 September 1994) |
| A/AC.105/589 | Report on the United Nations/International Astronautical Federation Symposium on Benefits of Space Technology for the Developing World: From Economic Growth to Environmental Protection (Israel, 6-9 October 1994) |
| A/AC.105/591 | Satellite-based radio broadcasting services |

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| A/AC.105/592 and Add. 1, 2, 3 and 4 | Implementation of the recommendations of the Second United Nations Confe-Conference on the Exploration and Peaceful Uses of Outer Space: International cooperation in the peaceful uses of outer space: activities of Member States |
| A/AC.105/594 | Report on the United Nations/European Space Agency Training Course for Latin American and Caribbean Countries on the Monitoring of Natural Resources, Renewable Sources of Energy and the Environment using Data from the European Remote Sensing Satellite (18-28 April 1994, Frascati, Italy, and 29 April 1994, Rome) |
| A/AC.105/595 | Report of the United Nations Expert on Space Applications |
| A/AC.105/596 | Report on the United Nations/European Space Agency Workshop on Global Change and Training Course on Microwave Remote Sensing Applications (Lima, 3-4 and 5-14 October 1994) |
| A/AC.105/601 | Implementation of the recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space: International cooperation in the peaceful uses of outer space: Programmes of international organizations |

Item 7 - Use of nuclear power sources in outer space

Item 8 - Space debris

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| A/AC.105/593 and Add.1, 2 and 3 | National research on space debris: safety of nuclear-powered satellites: Problems of collisions of nuclear-power sources with space debris |

Item 10 - Examination of the physical nature and technical attributes of the geostationary orbit; examination of its utilization and applications, including, *inter alia*, in the field of space communications, as well as other questions relating to space communications developments, taking particular account of the needs and interests of developing countries

Item 12 - Progress in national and international space activities related to the Earth environment, in particular progress in the Geosphere-Biosphere (Global Change) Programme

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| A/AC.105/590 | Global Change: Participation of developing countries and possibilities of enhancing it |

Item 15 - The theme fixed for special attention at the 1995 session of the Scientific and Technical Subcommittee: "Application of space technology for education, with particular emphasis on its use in developing countries"

Item 16 - Other matters

(a) Third UNISPACE

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| A/AC.105/575/Add.1 | Matters related to the possible holding of a third United Nations Conference on the Exploration and Peaceful Uses of Outer Space |

(b) Other reports

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| A/AC.105/583 | Highlights in space: Progress in space science, technology and applications, international cooperation and space law, 1994 |
| A/AC.105/597 | Report of the World Meteorological Organization |
| A/AC.105/598 | Report of the European Telecommunications Satellite Organization |
| A/AC.105/599 | Report of the International Telecommunications Satellite Organization |
| A/AC.105/600 | Report of the European Organisation for the Exploitation of Meteorological Satellites |
| A/AC.105/602 | Membership of the Committee on the Peaceful Uses of Outer Space |
| A/AC.105/603 | Report of the International Telecommunication Union |
| A/AC.105/604 | Report of the International Society for Photogrammetry and Remote Sensing |

Working Group of the Whole to Evaluate the Implementation of the Recommendations of UNISPACE 82

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| A/AC.105/C.2/WG.6/L.10 and Add.1, 2 and 3 | Draft report of the Working Group of the Whole to Evaluate the implementation of the Recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space on the work of its ninth session |

## Annex II

## REPORT OF THE WORKING GROUP OF THE WHOLE TO EVALUATE THE IMPLEMENTATION OF THE RECOMMENDATIONS OF THE SECOND UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE ON THE WORK OF ITS NINTH SESSION

1. The Working Group of the Whole to Evaluate the Implementation of the Recommendations of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82) was re-established for its ninth session by the Scientific and Technical Subcommittee in accordance with General Assembly resolution 49/34, paragraph 15, of 9 December 1994, with a view to improving the execution of activities relating to international cooperation, particularly those included in the United Nations Programme on Space Applications, and to proposing concrete steps to increase such cooperation as well as to make it more efficient. The Working Group held a series of meetings from 8 to 16 February 1995, during the thirty-second session of the Scientific and Technical Subcommittee. At its meeting on 16 February 1995, the Working Group adopted the present report.

2. Mr. Muhammed Jameel (Pakistan) was elected Chairman of the Working Group. The Chairman, in his opening statement, reviewed the mandate of the Working Group for its ninth session and the status of the implementation of the recommendations of UNISPACE 82.

3. In accordance with resolution 49/34, paragraph 15, the Working Group of the Whole continued its assessment of the implementation of the recommendations of UNISPACE 82. The Working Group had before it a number of studies and reports prepared by the Secretariat, Member States and international organizations, contained in documents A/AC.105/592, Add.1, 2, 3 and 4, A/AC.105/595 and A/AC.105/601. The Subcommittee also had before it two technical studies prepared by the Secretariat, one on Global Change: Participation of developing countries and possibilities of enhancing it (A/AC.105/590), and one on Satellite-based radio broadcasting services (A/AC.105/591).

4. The Working Group noted that the Secretariat was also in the process of preparing additional technical studies on the subjects it had suggested at its previous session, as outlined in document A/AC.105/571, annex II, paragraph 17.

5. The Working Group noted with satisfaction the valuable efforts of the United Nations, Member States and other international organizations to implement the recommendations of UNISPACE 82.

6. The Working Group agreed on the following conclusions and recommendations, keeping in view the priorities contained in General Assembly resolution 49/34, paragraph 13.

### I. SHORT-TERM TRAINING AND LONG-TERM EDUCATION

7. The Working Group noted with appreciation that training courses in remote sensing, satellite communications and other topics have been organized for the benefit of developing countries with the assistance of the United Nations. Such seminars and workshops on advanced applications of space science and technology and on new technological developments should continue to be organized regularly. At the same time, the recent advances in space technologies and applications for development should be brought to the attention of planners, administrators and decision makers in the developing countries. Member States, particularly the developed countries, and international organizations are requested to support the training programme on an ongoing basis.

## II. INTERNATIONAL AND REGIONAL COOPERATION

8. The Working Group noted with appreciation the reports prepared by the Office for Outer Space Affairs on the resources and technological capabilities of States in space activities as well as in the areas of education, training, research and fellowship opportunities for the promotion of cooperation in the peaceful uses of outer space. Those reports should continue to be periodically updated by the Office for Outer Space Affairs.

9. The Working Group recommended that in the light of the continued development of space activities, the Committee on the Peaceful Uses of Outer Space should request all States, particularly those with major space or space-related capabilities, to continue to inform the Secretary-General annually, as appropriate, about those space activities that were or could be the subject of greater international cooperation, with particular emphasis on the needs of the developing countries.

10. Similarly, the Committee should also request international organizations with space-related activities to continue to inform the Secretary-General annually concerning those space activities that were or could be the subject of greater international cooperation, with particular emphasis on the needs of the developing countries.

## III. INFORMATION, STUDIES AND TECHNICAL ADVISORY SERVICES

11. In order to promote the development of national space programmes, including higher education in space-related subjects, the United Nations should continue to arrange, upon request, for the provision of expert consultants from developed and developing countries to assist in the preparation of integrated national plans of action for initiating, strengthening or reorienting appropriate space applications programmes, which should be in conformity with other national development programmes.

## IV. OTHER MATTERS

### A. Priority areas

12. The Working Group considered that, in further efforts to promote the applications of space science and technology for development, priority should be given to the following areas:

(a) Stimulation and support of the growth of indigenous nuclei and an autonomous technological base in space technology in developing countries. UNISPACE 82 recommended the free exchange of scientific and technological information and an arrangement for the transfer of technologies to promote the use and development of space technology in the developing countries. UNISPACE 82 also recommended that countries should not place undue restrictions on the sale of components, subsystems or systems required for peaceful space applications. A greater international understanding therefore needs to be evolved to overcome the difficulties faced by the developing countries in this respect;

(b) Promotion of a greater exchange of actual experiences in space applications. UNISPACE 82 recommended appropriate assistance and called particularly upon international financial agencies to support demonstration projects to provide opportunities for hands-on experience in space technology and applications for the developing countries through direct involvement in such applications projects or pilot projects;

(c) United Nations funding. The Programme on Space Applications should be given the full support of the United Nations in order to fully implement the recommendations of UNISPACE 82. That recommendation was made on the understanding that the Office for Outer Space Affairs would give priority to the full implementation of the Programme on Space Applications within the available resources of its regular budget;

(d) Voluntary contributions. Appreciation was expressed for the support of Member States and international organizations in the form of cash and in-kind contributions for the activities being undertaken by the Programme on Space Applications for the implementation of the UNISPACE 82 recommendations. Those Member States and international organizations were requested to continue their support and other Member States and international organizations were urged to provide cash and in-kind contributions for Programme activities, in particular those that are not implemented due to a lack of financing.

## B. Third UNISPACE

### Introduction

13. The General Assembly, in its resolution 47/67, paragraph 20, of 14 December 1992, recommended that the Committee on the Peaceful Uses of Outer Space at its 1993 session should begin discussions on the possibility of holding a third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE). Pursuant to that recommendation, the Scientific and Technical Subcommittee and the Committee at their 1993 sessions considered in general terms the question of holding such a conference, including the goals and objectives for the proposed conference, as well as matters related to organization, venue, timing and funding implications.

14. In response to a request contained in General Assembly resolution 48/39, paragraphs 22 and 23, the Scientific and Technical Subcommittee and the Committee continued their discussions on the matter in 1994, and agreed that they should define a set of sharply focused objectives for such a conference, including details such as organization, venue, timing and funding, with a view to promoting an early conclusion on the matter by the Committee. Resolution 48/39, paragraph 24, noted that the goals set for such a conference might be achieved through other means, including intensification of work within the Committee.

15. Working papers on various matters related to the holding of such a conference were submitted by Pakistan (A/AC.105/C.1/L.191), India (A/AC.105/C.1/L.195) and the Group of 77 (A/AC.105/C.1/L.199). The latter represented an amalgamation and expansion of the views contained in the Indian and Pakistani papers. At this session the Government of India reiterated its offer, originally made at the thirty-sixth session of the Committee in 1993, to host a third UNISPACE conference at its Space Centre in Bangalore.

16. The Subcommittee, in paragraph 113 of its report (A/AC.105/571), requested the Secretariat to prepare, in time for the next session of the Committee, a comprehensive report on the likely organization, funding and logistical implications of holding such a conference. The report should include an analysis of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82), held in Vienna, Austria, in August 1982, including its organization, funding and logistics, as well as an analysis of various combinations of duration, scope and venue (including United Nations headquarters cities and other sites) for a third UNISPACE Conference.

17. In accordance with that request, the Secretariat submitted a report to the Committee at its thirty-seventh session in June 1994 (A/AC.105/575). To facilitate further consideration of the matter, the Committee requested the Secretariat to compile a document, in time for consideration at the current session of the Scientific and Technical Subcommittee, containing the various ideas submitted to the Committee regarding the agenda and organization of a third UNISPACE Conference. In accordance with that request, the Secretariat brought out a report contained in document A/AC.105/575/Add.1.

18. The General Assembly, in its resolution 49/34, paragraph 26, of 9 December 1994, agreed that the Third United Nations Conference on the Exploration and the Peaceful Uses of Outer Space could be convened in the near future and also agreed that, prior to recommending a date for the Conference, there should be a consensus recommendation on the agenda, venue and funding of the Conference. The General Assembly further recommended that the Scientific and Technical Subcommittee, at its thirty-second session, should conduct a thorough analysis and define an agenda for such a conference, and agreed that the Subcommittee should discuss a broad range of themes and subjects that could be refined into a sharply focused and detailed agenda and should also continue its examination of other means of achieving the goals set for such a conference. These discussions should provide the basis for a prompt decision by the Committee on a recommendation to the General Assembly regarding the agenda, timing, funding and organization of the Conference.

19. While examining the matters related to a possible holding of the third UNISPACE Conference, during the thirty-second session of the Scientific and Technical Subcommittee, the Working Group of the Whole of the Subcommittee set up an informal, open-ended drafting group under the Chairmanship of Mr. Richard Tremayne-Smith (United Kingdom) with the task of preparing a report on the matter, based on discussions among members and the background material already available. Such a report, when adopted by the Working Group of the Whole and the Subcommittee, could undertake the tasks entrusted by the General Assembly to the Subcommittee, as noted in paragraph 18, above.

20. The drafting group held seven meetings. Based on these discussions, the report of the drafting group was formulated in a way that sets out the varied views of all delegations on such a conference. The drafting group also developed an indicative agenda for such a conference, as contained in the appendix to the present annex, which encompassed a broad range of themes and subjects that could be refined into a sharply focused and detailed agenda at a later stage. The Working Group of the Whole agreed that further discussions would take place at the thirty-eighth session of the Committee on the Peaceful Uses of Outer Space.

21. In addition to the above background, the drafting group had the benefit of the views expressed by Member States during the thirty-second session of the Scientific and Technical Subcommittee.

### 1. The opportunity

22. The first and second United Nations Conferences on the Exploration and Peaceful Uses of Outer Space were held with a time-gap of 14 years. It has already been 12 years since the last UNISPACE conference, held in 1982. Since then, there have been rapid advances, particularly in recent years, in all fields of space science and technology and in other relevant fields such as electronics, computer technology and materials science. The possibilities for practical applications that could provide economic benefits have also multiplied and have resulted in an increased role of the private sector in planning and implementing space activities. Also since then, the international political scene has changed and the perspectives and opportunities for international cooperation have been influenced by these changes, requiring a new assessment by the international community.

23. Since the beginning of the 1980s, when the last conference was held, developments have brought about corresponding changes in the perception of international space activities. The end of the Cold War has brought about cooperation partnerships between Member States that were heretofore not possible. In addition, the United Nations is currently adapting itself to this new international configuration and its participation in international space activities needs to be examined.

24. Another significant change relates to the growth, at the international level, of the awareness of the importance of the environment and the interdependence of countries. This growing awareness led to the convening of the United Nations Conference on the Environment and Development (UNCED) in 1992, which

succeeded in bringing about a new recognition and acceptance of the concept of "sustainable development", and the adoption by the Conference of the Agenda 21 plan of action. Many countries have made commitments to Agenda 21 that they intend to fulfil with or without significant use of space technology. At the same time, there have been great advances in all aspects of space technology, particularly those that contribute to sustainable development and the protection of the environment. These developments present a unique opportunity to establish the relationship between space applications and sustainable development and point to a strong need and justification for including the implementation of Agenda 21 in the agenda of any effort focusing on international cooperation and space applications.

25. While the States that are most active in space are members of the Committee on the Peaceful Uses of Outer Space, the 124 Member States that are not members of the Committee are also users of space technology. A third UNISPACE Conference would provide those States with the opportunity to participate fully in United Nations discussions on the peaceful uses of outer space. It would thus provide the members of the Committee with an opportunity to exchange information on space activities, policies, priorities and needs with those States and would encourage the broader use of space applications and participation in space activities.

26. Many countries, including those that are not members of the Committee on the Peaceful Uses of Outer Space, are in need of space applications and have an interest in space activities. Taking note of major changes in international science, including significant advances in space science and technology, since the last Conference in 1982, it is reasonable, after such a long gap, to provide a forum for all Member States to consider the policy-level issues related to outer space and its use under the framework of a United Nations conference. No other forum could effectively substitute or provide the catalytic role of a third UNISPACE Conference, particularly in meeting the challenges of maintaining and increasing effective international cooperation in this field, as it would not have the participation of all countries.

27. While other forums, such as the Space Agency Forum for the International Space Year, organized in the context of the International Space Year in 1992, have been quite effective in expanding international cooperation in space activities under universally relevant themes, such as "Mission to Planet Earth", their effect was primarily on countries with established space programmes. The expansion of such cooperation to include the needs of the developing countries in terms of their effective participation would require a third UNISPACE Conference. Such a conference could provide the necessary forum for matching existing capabilities in space and the strengths of available forums with current demands in developing countries. In addition, any conference should be informed of the progress of the work of such bodies as CEOS and the Space Agency Forum.

28. Another opportunity that exists is the possibility of examining ways and means of utilizing outer space as a non-renewable resource in a sustainable manner.

## 2. The objectives of the conference

29. The basic objective of the proposed third UNISPACE conference would be to promote effective means of using space technology to assist in the solution of problems of regional or global significance and to strengthen the capabilities of Member States, in particular developing countries, to use the applications of space research for economic, social and cultural development.

30. As a way of achieving this primary objective, the proposed conference should include a review of the recent developments in space activities including advances in space technology, new economic and social applications, and economic factors limiting the development of space technology and its applications. On the basis of that review, a third UNISPACE conference would consider how States can make the best use of existing systems and opportunities and how international cooperation should be strengthened, where

necessary, to provide new systems, applications and further opportunities for international cooperation for the general benefit of Member States. In particular, a third UNISPACE conference could consider, inter alia, how international cooperation in the field of remote sensing, weather and climate observations and environmental monitoring could be strengthened to promote the use of such systems by all States.

31. Together with the ways of achieving the primary objective, another objective or desirable result would be that developing countries would define their needs for space applications for development purposes in advance of any conference. At the same time, the conference would analyse the relationships between commercialization of space technology, national development plans and the building of indigenous capabilities with a view to further encouraging the partnership of the developing countries in the development and utilization of these technologies.

32. Another objective would be to consider ways of expediting the use of space applications in Member States to promote sustainable development, particularly through the implementation of the recommendations of Agenda 21 of UNCED as well as their participation in international programmes such as Mission to Planet Earth and the International Geosphere-Biosphere Programme or in various applications of satellite communications for commercial, educational or health purposes.

33. A third UNISPACE conference could address the various issues related to education, training and technical assistance in space science and technology and their applications aimed at the development of indigenous capabilities in all States to ensure that all can, in practice as well as in principle, use data from space systems.

34. The conference could serve as a valuable forum for increasing awareness of the general public regarding the benefits of space technology and critical evaluation of the value of space activities.

### 3. Organization of the conference

35. The drafting group considered various suggestions relating to the organization of the Conference, contained in document A/AC.105/575, paragraphs 52 to 78. The views that follow were also expressed by Member States during their discussions. The drafting group noted that the general principle of the General Assembly, that United Nations conferences and meetings should plan to meet at their respective established headquarters, should be considered as the starting point in considering the venue of the Conference.

36. The organization of the Conference should permit the participation of all States Members of the United Nations, including those who are not members of the Committee on the Peaceful Uses of Outer Space. It would be necessary to involve those Member States during the preparatory phases.

37. Such a conference would require thorough preparation and therefore the holding of such a conference in 1996 or 1997 is unrealistic. In addition, the resource requirements of the United Nations Programme on Space Applications should be carefully reviewed to ensure that the Programme could be effectively oriented towards conference preparations during the 18-month period prior to the conference. Such considerations should be taken into account in setting the date for the conference. In addition, the overall programme of major United Nations conferences should be taken into account in recommending a date in order to ensure that the financial burden is manageable within the scope of the overall United Nations budget.

### 4. Examination of achieving the goals set for the conference by other means, including intensification of work in the committee

38. The Working Group of the Whole noted that, through intensification of its work, the Committee could address several of the items which would result from an agenda based on some of the objectives that have

been indicated. For instance, the Committee could analyse the implications that the end of the Cold War might have for international cooperation on space activities. The Committee could also invite experts in relevant fields to make presentations to it and to prepare working documents to be reviewed by the Committee.

39. The Committee could also invite contributions, to be presented at its sessions, from a number of groups that specialize in a field of space science or technology to review recent scientific and technological developments. The Working Group of the Whole noted that groups such as the Space Agency Forum, the Committee on Earth Observation Satellites, the International Astronautical Federation, the Committee on Space Research and other such regional or international groups could provide the Committee with a valuable view of the current status and the expected developments in their respective fields.

40. The Working Group of the Whole also noted that some elements to be pursued in fulfilling the objectives of a possible third UNISPACE conference could be addressed in regular or ad hoc meetings of the groups referred to above as well as in regional or international conferences, symposia or meetings that address a range of themes and applications.

41. While recognizing that specialized groups, such as those mentioned above, can provide valuable insight into the important issues that concern specific space matters, the Working Group of the Whole noted that membership and participation in such groups and in their activities was of a diverse nature. In particular, the Working Group of the Whole noted that the work and discussions of these groups are primarily oriented to scientific and technical subjects and that high-level officials responsible for national development policy do not regularly participate in such events.

42. Recalling that space technology has an important role to play in economic and social development such as in implementing the recommendations of UNCED and Agenda 21 and that many countries which are not members of the Committee are or could be utilizing space technology for this and other purposes, the Working Group of the Whole agreed that a global conference on space, organized by the United Nations, could be an appropriate forum in which to discuss issues related to international cooperation, space policies, the participation of the private sector and implementation or follow-up actions relating to these questions as well as to other issues that might be of universal concern.

43. The Working Group of the Whole was of the view that the objectives indicated for a third UNISPACE conference could be better achieved if it examined space activity and international cooperation in this area as a whole and if during its preparatory phase, the forums provided by specialized groups and other regional or international conferences, symposia and meetings are utilized to define a few focused themes to be dealt with by a third UNISPACE conference. Specialized groups, such as those referred to above, should be invited to participate in the conference to assist in preparing realistic goals to be reached by it and achievable plans for follow-up actions that fall within their mandates.

44. In considering the convening of a third UNISPACE conference, the Committee should work with and involve major organizations in the above fields. These specialized groups may well be the best or most appropriate route to achieving the results required. Involving a group with a mandate in a specific field of space from the beginning, setting targets for it and asking it to report regularly on its progress is better than having all the recommended actions tied to a United Nations committee with limited resources. In addition, it would be desirable to identify mechanisms for input to and feedback from major funding organizations to pull through any resulting actions.

45. Some delegations expressed the view that, for tackling problems that require close coordination among countries, such as natural disaster management, a technical conference rather than a United Nations conference could be more effective.

46. The view was also expressed that the suggested agenda item on a review of existing mechanisms to augment the scientific and technical capabilities of developing countries, particularly those for education and training, is covered by the normal cycle of United Nations meetings and regular reports.

### 5. Additional ideas for consideration

47. It was recalled that during its 1994 session, the Committee on the Peaceful Uses of Outer Space accepted, in principle, that a third UNISPACE conference could be convened. It had been agreed that a formal decision on holding a conference would be made only after a thorough and balanced analysis of the agenda, venue and funding of such a conference. It was pointed out that the Subcommittee should hold discussions that could provide the basis for a prompt decision on the matter.

48. Some delegations expressed the view that not enough consideration had been given to the task of examining the possibility of achieving the goals set for a third UNISPACE conference through other means. Among these means, intensification and restructuring of the working plan, inter alia, the setting of the agenda of the Committee on the Peaceful Uses of Outer Space and its subcommittees should be carefully examined.

49. The view was expressed that as a result of the opportunities reflected in the report of the drafting group there now exists an opportunity for the international community to consider the needs of all countries with regard to space technology and the links between the various mechanisms that are available to meet those needs. The first step in this process, the outcome of which should be a major determining factor in a decision to convene a third UNISPACE conference, would be the development of a set of themes relating to space science and technology of common interest to the international community. Once this process is completed, it would then be possible to initiate discussion on how these issues could be most effectively addressed, whether through a third UNISPACE conference, existing mechanisms and forums for international cooperation in space activities or a combination of such measures.

#### Ideas regarding a possible agenda

50. It was agreed that the agenda of a possible third UNISPACE conference should be focused, well-balanced and consistent with the interests and needs of all countries. The agenda and preparations should be developed in such a way as to ensure that the conference is able to propose specific, well-defined and pragmatic recommendations. The entire spectrum of issues related to space development and related economic or security aspects cannot be included into such a focused agenda.

51. Some delegations suggested that international cooperation should not be contained in a rigid framework. Such cooperation should recognize the elements of voluntary interests among cooperating partners. The agenda of a possible third UNISPACE conference and possible deliberations should recognize these inherent aspects.

52. One of the elements recognized as essential for the growth of space activities, including commercial developments, is capacity building for space applications of all countries, particularly developing countries. It is stressed that a major conference such as a third UNISPACE conference should examine and review aspects related to education and training in space, which plays an important role in generating indigenous capabilities in developing countries.

#### Ideas regarding financial and other aspects related to holding a third UNISPACE conference

53. The members of the drafting group agreed that, while formulating recommendations regarding the possible holding of a third UNISPACE conference, a pragmatic and realistic appraisal of how those

recommendations would be implemented should be conducted and that this should necessarily include consideration of the available resources needed to implement those recommendations.

54. Some delegations expressed the view that, given both existing international cooperation and the severe financial constraints facing the United Nations and Member States, a third UNISPACE conference was not advisable at this time.

55. It was noted that the normal United Nations practice is to hold two major United Nations conferences a year and, if a third UNISPACE conference is scheduled as one such conference, it could be financed within the zero growth budget policy followed by the United Nations. It was also noted that if the conference is hosted by a Member State, all additional financial obligations resulting in the conference being held in that country, as compared to at a United Nations headquarters, would be borne by that country in accordance with relevant General Assembly specifications.

56. Some delegations suggested that the possibility of limiting the duration of the proposed conference, as well as the duration of other meetings, should be explored in order to reduce the financial burden. As a further cost-reducing measure, the possibility that the sessions of the Legal Subcommittee and the Scientific and Technical Subcommittee could be held consecutively, with an overlap of one week, to examine matters that required the views of both subcommittees, should be explored.

### Ideas regarding the objectives of a possible third UNISPACE conference

57. The view was expressed that the initial development of objectives for a third UNISPACE conference should not be too narrowly defined, bearing in mind that pre-conference efforts could fine-tune or redefine the objectives.

58. Recognizing its achievements and considering some of the drawbacks of the Second UNISPACE Conference, it was agreed that a detailed analysis is required to ensure that a third UNISPACE conference does not result in recommendations that are too general, ill-defined and idealistic.

### Other relevant ideas

59. Some delegations expressed the view that issues related to the revitalization of the Committee on the Peaceful Uses of Outer Space could be better dealt with through the Committee itself rather than through a third UNISPACE conference.

## C. Future work

60. The Working Group recommended that it be reconvened next year to continue its work.

## Appendix to annex II

## INDICATIVE AGENDA OF A POSSIBLE THIRD UNISPACE CONFERENCE

1. This indicative agenda has not been given detailed consideration, but is provided as a framework for future discussions by the Subcommittee and the Committee.

2. The agenda of the conference could be organized with three central themes and subjects as follows:

(a) Possibilities of cooperation in space science, technology and research;

(b) Applications of space science and technology, including those for sustainable development;

(c) Enhancing international cooperation in the utilization of space technology and applications.

3. Areas of particular emphasis should include:

(a) Expansion of participation in initiatives such as Mission to Planet Earth, started during the International Space Year 1992, through the Space Agency Forum, in order to promote and enable the participation of many countries, particularly developing countries;

(b) Major developments in space science and technology which provide opportunities and means for increased international cooperation;

(c) The contributions of space technology for promoting national and international programmes aimed at environmental protection and sustainable development.

4. The following is a suggested detailed agenda for a third UNISPACE conference.

### Committee I: Possibilities of cooperation in space science, technology and research

A. Evaluation of major developments in space science, technology and applications, and assessment of their utility for future economic and social development.

B. The future of solar system and planetary exploration.

C. Design, development and use of mini- and micro-satellites for space research.

D. Space- and ground-based astronomy.

E. The use of microwave systems for geophysical studies and oceanographic research.

F. Review of technical issues related to space debris, ensuring the safety of future space activities.

H. Better, faster and cheaper means of reaching space, including the case of human space flight.

J. Development of joint projects in the fields of space science, applications and exploration by scientists from developing and developed countries.

Committee II: Applications of space science and technology, including those for sustainable development

A. Environmental applications

1. Examining ways of improving space-based monitoring of the state of the global environment and improving archives, dissemination, use and exchange of Earth observation data; application of space technology in monitoring the environment at local and regional scales. Examination of mechanisms to integrate space technology and applications into international programmes to promote environmental protection and economic development.

2. Improving international cooperation in development and implementation of satellite-based disaster warning systems and utilization of space technology for mitigation and relief in natural, technological and industrial disaster situations.

3. Enhancing cooperation in the collection and dissemination of meteorological data from satellites and other sources.

B. Space technology for development applications

1. Remote sensing:

   (a) Improving capabilities for the reception, processing and utilization of remote sensing data for sustainable development and management of natural resources;

   (b) Improving distribution systems to ensure availability of remote sensing data, especially to developing countries, and ensuring the complementarity of remote sensing data.

2. Navigation:

   (a) Improving methods to ensure continuity in the availability of satellite-based position-location/navigational services and exploring the possibility of cooperative global navigational satellite systems;

   (b) Enhancing international cooperation in satellite-based search-and-rescue systems, including development of common standards for ship and aircraft locator beacons.

3. Communications:

   (a) Promoting regional cooperation in the planning, design, operation and utilization of satellite communication and broadcasting systems;

   (b) Examining the uses of mobile satellite communications and other new technologies, including low-cost, lightweight satellites in non-geostationary orbits (lightsats), for rural communications;

   (c) Promoting other uses of satellite-based systems, notably for tele-education, tele-medicine and family welfare, and emergency communications;

   (d) Examination of issues related to transnational satellite direct broadcasting, including protection of intellectual property rights.

4. Secondary applications of space technology:

   (a) Potential uses of space for manufacturing specialized/unique products and materials;

   (b) Industrial applications of spin-offs from space technologies.

Committee III: Enhancing international cooperation in the utilization of space technology and applications

A. Review of existing mechanisms to augment the scientific and technical capabilities of developing countries, particularly those for education and training, so that they may participate in and benefit from space activities, focusing on basic space science applications, exchange of information and experiences.

B. Review of existing mechanisms for international cooperation in space activities, consideration of ways and means for enhancing cooperation among Member States, the United Nations, its specialized agencies and other international organizations, with particular emphasis on the United Nations Programme on Space Applications.

C. International cooperation in maintaining and using the outer space environment - scope for new initiatives.

D. Review of existing global and regional funding sources available for cooperative space applications programmes and development of strategies for utilizing those sources.

E. Examination of the role of space technology in promoting international peace and security, including the development of confidence-building measures for space activities and the conversion of military space technology for civilian purposes.

F. Review of the current status and the need for continued progressive development and codification of the law of outer space, including ways and means of promoting wider adherence to international space treaties, establishment of guidelines for international cooperation in space exploration and utilization, and examination of links between space law and other branches of international law, such as environmental law.

Additional scientific and technical component of a third UNISPACE conference

5. In order to ensure adequate discussion of scientific and technical issues, particularly as they relate to the items on the agendas of Committee I and Committee II, it is proposed that, in addition to the regular Committee sessions, there be an additional scientific and technical component in the form of the following:

Poster sessions: A series of scientific poster sessions should be held at the conference facility and be open to participants and observers throughout the conference. The posters/papers will highlight the results from ongoing scientific and technical space projects and will be presented by national space agencies and international scientific organizations;

Public evening lectures: To be given by eminent scientists in various space-related scientific disciplines on subjects of broad interest to conference participants and the general public;

Workshops/seminars: To be held as part of the conference and to be organized by interested specialized agencies of the United Nations and other international organizations on topics relevant to their expertise and mandates. For example: communications (ITU), remote sensing (CEOS/FAO/UNEP), navigation (ICAO/IMO), meteorology (WMO), basic space science (UNESCO/COSPAR/IAF) and astronomy (IAU).

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# SCIENTIFIC AND TECHNICAL PRESENTATIONS TO THE SCIENTIFIC AND TECHNICAL SUBCOMMITTEE AT ITS THIRTY-SECOND SESSION

## Report by the Secretariat

1. During the thirty-second session of the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space, the Committee on Space Research (COSPAR) of the International Council of Scientific Unions (ICSU) and the International Astronautical Federation (IAF) organized, in liaison with Member States, a symposium on the theme "Applications of space technology for education, with particular emphasis on its use in developing countries" to complement discussions within the Subcommittee on that theme. This symposium was organized in accordance with the recommendation of the Subcommittee at its thirty-first session (A/AC.105/571, para 121), which was subsequently endorsed by the Committee on the Peaceful Uses of Outer Space at its thirty-seventh session[1] and by the General Assembly in its resolution 49/34 of 9 December 1994.

2. The symposium was the eleventh to be organized by COSPAR and IAF during the annual meetings of the Scientific and Technical Subcommittee, with the topic for each year selected by the Subcommittee at the previous session. The symposium was held in two parts, on 6 and 7 February 1995, following the completion of debate in the afternoon meetings of the Subcommittee during the first week of its session.

3. In addition to these special presentations organized by COSPAR and IAF at the request of the Subcommittee, Member States provided a number of scientific and technical presentations by specialists in space science and applications relating to various items on the agenda of the Subcommittee. Several national and international organizations also made special presentations on their scientific and technical activities.

4. In order to make more widely available the information on recent developments in space science, technology and applications presented during the symposium and the other presentations, the Secretariat has prepared a summary of that information, which is presented below.

5. The annex contains a more detailed description of the scientific and technical presentations made before the Scientific and Technical Subcommittee at its thirty-second session. Because of the technical character of the material, the annex is in English only. A list of the presentations and the speakers is contained in the appendix to the annex.

## SUMMARY OF PRESENTATIONS

### I. Symposium on Applications of Space Technology for Education

6. Despite global recognition that health and education are the essential building blocks of a sustainable society, serious shortcomings and unequal distribution in education and health-care services remain. A recent study estimates that two billion people have either minimal access to basic education or health care, or are completely lacking access to these services. Predicted population increases will put even more strain on future efforts to provide education and health care services. Limited access to educational and health-care services is generally driven by complex economic, political, social and cultural factors. A single technological project cannot hope to resolve such vast and complex shortcomings. It has, however, been demonstrated that technology can improve the situation. Modern telecommunications technology has the potential to play an important role in this situation, in particular given its ability to reach many people at a reasonable cost.

7. Satellite communications plays a very significant role in distance education. Many developing countries cover large geographical areas and have sparsely distributed populations. Transportation in remote areas, mountain regions, islands and deserts is poor and communication links are hard to establish. The limited availability of resources in many developing countries does not permit establishment of the costly infrastructure needed to meet developmental needs. Thus, satellite communications is probably the only way to educate people in rural areas and difficult geographical locations. Tele-education and tele-health involve the use of telecommunication techniques to provide educational or medical services over long distances. Common examples are the use of satellite television to teach students in remote areas, or a doctor in a remote area transmitting an X-ray image to a specialist thousands of kilometres away for consultation.

8. In an effort to address the globally unbalanced provision of educational and medical services, participants in the 1994 summer session of the International Space University (ISU) proposed the creation of a Global Access Tele-health and Education System (GATES). By using the advanced communications and information technologies in tele-health and tele-education applications, GATES aims to improve basic education and medical care on a global scale. The goal of the GATES project is to reduce inequalities in health and education within countries and between countries by providing global access to health care and educational services using telecommunications technology. The unique aspects of the proposed GATES system are that it takes a global approach and it has the dual objective of combining education and health care. This dual approach is justified by the fact that the highest educational and medical needs generally appear in the same areas. Furthermore, the basic communications requirements for educational and health care services are very similar.

9. In the United States, the Global Learning and Observation to Benefit the Environment (GLOBE) programme was proposed in 1994 to bring school children, teachers and scientists from around the world together to enhance environmental awareness of individuals worldwide, increase scientific understanding of the Earth and support higher standards in science and mathematics education. The GLOBE programme combines the use of comprehensive environmental educational materials with the opportunity for students to conduct hands-on science projects. Educational materials have been developed and, where possible, adapted from existing environmental education materials by environmental educators and curriculum development specialists.

10. Broad international participation is integral to the design of the GLOBE programme and to the achievement of its goals. The programme is therefore seeking international participation by countries throughout the world. The educational programmes of the United States National Aeronautics and Space Administration (NASA), developed and managed by its Education Division, uses unique facilities and laboratories, supporting more than 300 local, regional and national programmes. In addition to national

programmes run from NASA headquarters, field centres manage a number of education programmes that are designed to reach out to the educational community that is in close geographic proximity to each centre to meet local needs. Examples include the "Summer High School Apprenticeship Research Program" (SHARP), involving more than 400 minority high school students, and the "Graduate Student Researchers Program", providing support to train students in NASA related disciplines at both the master's and the doctoral levels.

11. The Canadian Fort Whyte Centre for Environmental Education in Winnipeg is designed to carry the message of interdependence to approximately 50,000 students and adults annually. Located on a reclaimed clay quarry, the Centre spreads over 200 acres of forest, lakes and self-guiding trails. From kindergarten to high school, over 35,000 students annually participate in the Centre's school and youth group programmes. School programmes are offered in both English and French. Natural history subjects provide a basic understanding of local and global ecosystems, while sustainable living programmes provide insight into personal environmental impacts of everyday life.

12. Brazil has some geographical characteristics, such as a large land mass, and inaccessible and sparsely populated territories that make it very suitable for the use of space technology. One of the most significant activities in the field of applied space applied research during the 1960s and 1970s was the Advanced Interdisciplinary Communications Satellite (SACI), the planning of which started in 1968. The central objective of this project was the establishment of a national tele-education system, using direct satellite broadcasting as the means for relaying educational television programmes to all parts of the country. The SACI project started with the formation of an interdisciplinary group, with about 150 specialists, both Brazilian and from other countries, and with the creation of a master degree course in educational technology.

13. Since its creation, in 1961, the Brazilian National Institute for Space Research (INPE) has organized graduate courses in order to create a group of space specialists to work on its research and development projects. For the past nine years, INPE has been offering an international specialization course on remote sensing, in cooperation with the United Nations University (UNU), the United Nations Office for Outer Space Affairs, the European Space Agency (ESA) and ministries of education and science and technology. Since 1985, the course has had 59 participants from Latin America and Africa. The main objective of the course is to provide specialists from developing countries with information and hands-on experience with the techniques and methodologies of remote sensing for the study and monitoring of natural resources.

14. In India, education is considered as an integral part of the country's development process and thus has been accorded a high national priority. Presently, the utilization of the Indian National Satellite (INSAT) system in meeting the educational requirements is acclaimed and well accepted all over the country. The INSAT system is being efficiently utilized for a number of applications, such as educational TV programmes, interactive training programmes and mass communication programmes to various target groups. Efforts are underway to fully harness the space capabilities not only in meeting the educational needs, but also to ensure that it becomes the carrier of information and awareness to the predominantly rural population of India.

15. The Indian Space Research Organization (ISRO) is working on a new concept of a dedicated educational satellite system. This aims at utilizing the most powerful audio-visual medium using dedicated "GRAMSAT" satellites, which will be specifically tailored to meet the basic requirements of rural areas to disseminate culture and region-specific knowledge on health, hygiene, the environment, family planning and better agricultural practices in each of the regional languages. The GRAMSAT satellite concept includes from six to eight high-powered C-band transponders which, together with video compression techniques, can disseminate region and culture specific audio-visual programmes in each of the regional languages. The high power C-band transmission will also enable linguistic minorities in other States to receive programmes in a language of their choice in a direct reception mode, only requiring a 2-metre antenna.

16. Since its creation in 1962, the French National Centre for Space Studies (CNES) has paid great attention to the education of youth in the field of space applications. One possibility is the organization of summer schools on particular subjects and support of youth clubs. The most popular club activities include launchings of balloons and model rockets. In 1993, the Groupement pour le développement de la télédétection aérospatiale (GDTA), founded in 1973 by CNES and the Institut géographique national), held courses for more than 500 trainees. A high proportion of these trainees come from central and eastern European countries. All GDTA courses place great emphasis on the use of satellite data in the Geographic Information System and involve a substantial amount of practical work.

17. The German Remote Sensing Data Centre (DFD) of the German Aerospace Research Establishment (DLR) has developed and operates the Intelligent Satellite Data Information System (ISIS) as a central user interface of its Data and Information System. The major objectives of ISIS are to supply a broad user community with relevant information required for the assessment and selection of appropriate remote sensing data, and to enable access to archives for the acquisition of data. Inherent in this process is the generation of digital browse quicklooks for the user interface. Until now, more than 30,000 compressed digital quicklooks have been integrated.

18. In Israel, a process has been initiated to improve the quality of and expand space science and engineering education at the collegiate level by compiling a baseline set of information on activities related to space science and engineering at institutions of higher education. As space research is usually multidisciplinary, the teaching of most space research areas is included within the framework of existing disciplinary courses. As an example, planetology has fundamentally altered the understanding of atmospheric physics and chemistry. However, the results of space research affect teaching areas in differing degrees. In some disciplines, such as astronomy and astrophysics, the impact of the results of space research have been so basic and extensive as to change those disciplines in a fundamental fashion.

19. One of the most important initiatives in this direction was a series of educational "Lectures from space" performed in 1993 by V. Tsibliyev and A. Serebrov, the crew of the orbital station Mir. It was inspired by the idea of the space educational programme intended for Christa McAuliffe, which was not realized due to the tragic incident of the space shuttle Challenger in 1986. The developer of the Russian project is cosmonaut A. Serebrov who, together with A. Viktorenko, commander of the fifth main crew of the Mir station, performed three space-borne lectures on ecology, microgravity physics, biology, medicine and geography at the end of 1989 and the beginning of 1990. The project has been recently continued by the fifteenth and seventeenth Mir station crews.

20. The EURISY Workshop on "Distance Learning and Environmental Awareness - the Role of Satellites" was held at Frascati, Italy, from 21 to 23 September 1994 with the active support of Telespazio, ESA, the European Space Research Institute (ESRIN) and the United Nations Educational, Scientific and Cultural Organization (UNESCO). The aim of the Workshop was to enable teaching, telecommunications and Earth observation specialists to present new technologies and to consider how they could develop, trade experience and explore ways of encouraging the use of distance learning methods, in particular with regard to the environment. This successful event brought together 100 specialists from Europe, the United States of America, Asia, Africa and Latin America. Conclusions and recommendations of this Workshop provided important insight into these new fields.

## II. Other scientific and technical presentations

### A. Space debris

21. Objects moving in near-Earth orbit are tracked and catalogued by the United States Space Command Space Surveillance System. This system operates more than 24 radar and optical facilities to monitor near-Earth space and maintains a catalogue of orbital elements of all tracked objects. The minimum diameter of observable objects is about 10 cm for low Earth orbits (LEO) and 1 m for the geostationary orbit (GSO). The catalogued objects represent about 99 per cent of the total on-orbit mass (roughly 3,000 metric tonnes) but only from 5 to 20 per cent of the debris larger than 1 cm. The amount of debris in the 1-10 cm range is estimated to be between 35,000 and 150,000 and the population of particles larger than 1 mm is probably more than 1,000 times the catalogued population.

22. In the past year, 89 successful launches into outer space have been carried out (compared to 79 in 1993). The total number of trackable objects in space is steadily increasing (7,860 at the end of 1994). More than 40 per cent are fragments of rocket upper stages and spacecraft as a result of explosions. As of the end of 1994, 124 known breakups have occurred. Only about 6 per cent of the catalogued objects are operational spacecraft. In 1994, six new fragmentations were observed.

23. Europe is making a significant contribution to the expansion of knowledge of small-size particles with the ESA European Retrievable Carrier (EURECA), the returned solar array panel of the Hubble Space Telescope (HST) and other spacecraft. The spacecraft surfaces are covered with craters from a large number of impacts of micrometeoroids and debris. The size of individual craters and holes range from 20 microns to several millimetres. A preliminary analysis of EURECA shows that the number of large impacts is larger than expected. The first visual inspection of the retrieved panel revealed a large number of impacts, with the largest hole roughly 2-3 mm in diameter. The results from the EURECA and HST panel impact analyses will be used to validate current reference flux models for small meteoroids and space debris.

24. A 24-hour measurement campaign in LEO with facilities located in Europe was carried out on 13 and 14 December 1994. The radar stations involved were in Wachtberg-Werthhoven (Germany) and Fylingdales (United Kingdom of Great Britain and Northern Ireland), Herstmonceux (United Kingdom) and Zimmerwald (Switzerland). The purpose of the campaign was to observe a specific volume in space, detect all objects of a minimum size passing through that volume and compare results with predictions by a space debris model. Preliminary analysis of a limited amount of data within 19 hours resulted in 26 detections of such objects. Similar campaigns carried out with the Haystack radar (United States) show that current space debris models overestimate the number of debris at lower altitudes (300-500 km), while at higher altitudes (800-1,000 km) the number is underestimated.

25. Several strategies, including shielding of the critical components of a spacecraft, can be adopted for protecting a spacecraft from the consequences of orbital debris impacts. However, the only efficient way to avoid collisions of the spacecraft with orbital debris greater than 1 cm in size is to alter the spacecraft's orbit. To achieve this, the spacecraft must be manoeuvrable and predicted future positions of the spacecraft and space debris must be known with sufficient accuracy. The accuracy requirements of predictions depend on the spacecraft and its manoeuvrability. Predictions must be sufficiently accurate to avoid false alarms and to provide high confidence of predicted collisions. Since the manoeuvrability of the proposed International Space Station is limited to a few manoeuvres per year and at a distance of a few hundred metres, the accuracy of the predicted positions must be very high.

26. At the Astronomical Observatory of the Poznan University (Poland), the theories and computer programs have been developed which enable computation of very precise predicted positions of artificial Earth satellites. Using these computer programs, the predicted positions of satellites at the given time can be computed by

applying different models of the Earth gravity field and then compared. Resulting differences are an estimation of the prediction accuracy of a collision between the spacecraft and debris. For the Space Station orbit (400 km altitude, 28.5° inclination), they are 233 m after 24 hours and 751 m after 10 days.

27. The University of Southampton (United Kingdom) continues to develop its expertise in short-term risk modelling of the space debris environment. This modelling approach has been applied to investigate the effects of satellite breakup and debris impingement on a number of satellite systems, including the breakup of one of a family of constellation satellites. The study concluded that the short-term collision risk following a satellite breakup in a modest-sized constellation was low, but may increase to significant levels if a large number of satellites were included in a constellation.

28. The United Kingdom Defence Research Agency (DRA), which acts as a national technical advisory service to groups new to this field, continues to build its experience in predicting orbital lifetime and re-entry of debris objects. More recently, it has outlined an environmental management plan based upon the concept of sustainable development. This recognizes the impracticability of zero pollution and accepts a contaminated, but survivable, orbital environment in which normal operations can continue economically and with relative safety.

29. Besides the artificial objects in the near-Earth space, there is also the natural environment: the meteoroids - a large number of particles whose size varies typically from a fraction of micron to millimetres. Meteoroids cross the Earth's orbit at very high velocities, on average 2-3 times the velocity of objects in LEO. In France, a study aimed at analysing and modelling the directivity of meteorite flux in the terrestrial and interplanetary environment is being prepared, because existing models based on experimental results do not provide information on the direction of the impact. The problem will be dealt with by considering the particles not as independent objects, but as a group with a density that can be approached by mathematical modelling.

30. The spatial density of debris is quite pronounced in the Indian Remote Sensing (IRS) satellite's altitude band of 800-1,000 km. This altitude band has a low rate of orbital decay and therefore debris have a protracted lifetime in these orbits. To assess the possible risk to active spacecraft in this band, Indian specialists have developed an analytical model of the trackable debris, characterizing the debris with its mass, size and orbital information. This model, which lends itself to extension to the untrackable region, has been developed at ISRO headquarters in Bangalore. It compares very well with experimental findings and is an improvement over other existing models for space debris characterization at a given altitude belt.

31. According to the International Telecommunications Union (ITU), there are about 322 active and derelict spacecraft and 111 rocket bodies and other associated objects in the region of GSO (data effective October 1991). Most of these objects are no longer subject to active control by their original operators. For purposes of considering environmental measures, GSO may be defined as the mean Earth radius of 42,164 km ± 300 km and extending to 15 degrees on both sides of the equator (which corresponds to a distance of approximately 10,000 km). These dimensions are dictated by the initial conditions at loss of control of the spacecraft and the influence of lunar and solar perturbations, solar pressure and the tesseral terms of the Earth gravity field.

32. Boosting the orbit of geostationary satellites near the end of their functional lifetime appears to offer the advantage of reducing the near-term collision probability by some amount. Because of the orbital characteristics of the current population in GSO, the change of perigee altitude should be by 300 km or more and the apogee should also be altered by a comparable amount. The mean perigee increase of the objects re-boosted to date is about 250 km. If the spacecraft re-boost manoeuvres are to have any long-term beneficial effect, they must include measures to preclude explosions.

33. So far, ESA has applied on a voluntary basis several debris prevention and protection measures. They are in the following areas: reorbiting of geostationary satellites, passivation of the Ariane third stage, reduction of mission-related objects and shielding of manned vehicles. The following ESA geostationary satellites have already been reorbited: OTS 2 (orbiting 318 km above GSO), GEOS (2,260 km), Meteosat 2 (334 km), ECS 2 (335 km) and Olympus 1 (due to a failure, this satellite has been left at orbit 213 km below GSO). Similar measures are also applied also by the International Satellite Telecommunications Organization (Intelsat) and satellite operators in the United Kingdom.

### B. Adverse environmental impacts on astronomy

34. In the area of space debris pollution of astronomic observation, an early agreement on an index of adverse impact might be reached. There are only three major international Schmidt telescopes in operation: the Mt. Palomar Schmidt in California, the Anglo-Australian Schmidt in Australia and the European Southern Observatory Schmidt in Chile. There is a feeling that a straightforward index of debris trails per plate or per hour of exposure would be an adequate, readily determinable index. Not only would this information be of value in establishing and monitoring astronomical complaints, but it would also assist in establishing the trend in production/reduction of debris in the size range recorded on deep sky plates.

35. The prospect of advertising from space, using solar reflectors or other techniques to produce bright images, is the ultimate fear for the observational astronomy community. Several such suggestions for advertising from space have emerged recently. The Space Billboard, a kilometer-sized solar reflector was proposed in 1993 and in 1994, the press published the story that SkyTV was considering a scheme to use space-borne lasers to project its logo as a hologram. Neither project was envisaged to have a long lifetime, but both are indications of commercial thinking on the use of space.

36. The beaming of solar power from space is once again under discussion. A further project in this area is the Russian Znamya project, a focused reflector designed to produce outdoor illumination. This project is of a different type to the advertising reflectors as it has practical usefulness in regions where other forms of street lighting may not be available. In astronomical terms, however, a focused reflector may be more damaging than a simple plain reflector.

### C. The use of nuclear power sources in outer space

37. According to recent research conducted in the Russian Federation, the safety of nuclear power sources (NPS) in space could be guaranteed in two ways: by keeping NPS construction intact (used in case of Radioisotope Thermoelectric Generators (RTG)), or by allowing the dispersion of NPS fuel in case of accidents (for nuclear reactors). During the launch of NPS systems into orbit, the following accidents could happen: explosion followed by the shock wave and debris bombardment, fire with changing temperature of flames, atmospheric re-entry with corresponding aerodynamic heating and finally the impact to the Earth surface.

38. Reactors of some low-orbiting Cosmos satellites use thermoelectric convertors with liquid metal heat transfer agents. Aerodynamic disintegration of the reactor and dispersion of the fuel (uranium-molybdenum alloy with enriched uranium-235) are performed by the aerodynamic dispersion system by ejecting the assembly of fuel rods from the reactor casing. A new system is currently under development. The reactor has construction locks with two positions: during the launching, parts of the reactor are separated and therefore subcritical; after successful orbital injection, parts are mechanically relocated into its compact body and the reactor becomes operational.

39. Among the areas of difficulty identified in the existing Safety Principles for the use of NPS in outer space are the exclusion of important areas such as nuclear propulsion; their formulation in

technology-dependent terms which are becoming outdated as new developments occur; and some lack of consistency with the better-developed safety principles for terrestrial NPS. Although there is as yet no consensus on the framework for a revised set of Principles, it seems inevitable that any revision must include the principle of justification, the requirement to demonstrate a net positive benefit from the use of NPS in space. According to the United Kingdom, this requirement for the justification of risks is fundamental to the radiological protection principles promulgated by the International Commission on Radiation Protection (ICRP) and is assumed in the International Atomic Energy Agency (IAEA) considerations of nuclear safety.

## D. Remote sensing of the Earth

40. Remote sensing of the Earth is one of the most important space activities in France. In this context, France is cooperating with ESA on the ERS and Envisat programmes, with the United States on the Topex/Poseidon programme and it also has its own national programme, SPOT. Even in this national programme, there is important bilateral cooperation with Belgium and Sweden aimed at continuous operation of the ground and space sector. The space segment consists of the SPOT 1, 2 and 3 satellites. The next satellite should be launched not later than in 1997 and will be equipped with multispectral detectors having resolution up to 10 m with possibility of stereoscopic images. Recently, France decided to continue this programme with satellites SPOT-5A and 5B having improved parameters (resolution up to 5 m, the possibility of more operational provision of stereoscopic data and digital recording instead of mechanical tape recording). These improved satellites should be launched in 2002 and 2007, assuring continuation of the programme at least until 2012.

41. The main contribution to the World Ocean Circulation Experiment (WOCE) ocean monitoring programme is made by the French/United States altimetric satellite Topex/Poseidon, launched on 10 August 1992 and still perfectly functional. The latest estimates of the root mean square (RMS) error in the determination of the local instantaneous level of the ocean is 4.7 cm, which is more than twice the expected 13.4 cm. It is, however, still above the 2 cm accuracy needed for the monthly mean sea level in the WOCE project. Data analysis revealed direct evidence of the seasonal variances of several centimeters in the sea topography and propagating effects of the climatic anomaly known as El Niño.

## E. Spin-off benefits of space technology

42. Following the recommendations of the United Nations Committee on the Peaceful Uses of Outer Space, adopted during its meeting in June 1991, the United Nations Industrial Development Organization (UNIDO) developed an Outline of its Programme for Realizing the Benefits of New Technology Spin-Offs in Developing Countries (with particular reference to space technologies), which is mentioned in the Secretary-General's report on Coordination of Outer Space Activities within the United Nations System (A/AC.105/587). The key features of this programme are technology spin-off monitoring, assessment and forecasting, establishment of relevant databases, development of solutions to specific problems related to the technology transfer process and the funding mechanisms for its elements. The programme also includes assistance to countries in formulating and implementing a national policy and strategy in this area, as well as providing an international framework for the transfer and application of high-technology spin-offs.

## F. The use of satellite systems in air traffic management

43. In accordance with the 1944 Chicago Convention, which drafted the Convention on International Civil Aviation and created the International Civil Aviation Organization (ICAO), the Organization was charged with the task of charting a course of action to be taken to coordinate the identification and development of requirements of international civil aviation on a worldwide basis. Recognizing the increasing limitations of the contemporary air navigation systems and the resulting need for improvements to take civil aviation into

the 21st century, the ICAO special committee, established in 1983, resolved that complementary to certain terrestrial systems, satellite-based communications, navigation, and surveillance systems (CNS) would be the key to world-wide improvements and, in fact, represents the only viable solution in the long-term to overcome the shortcomings of the current system and to fulfil global needs and requirements of the foreseeable future.

44. In its long-term projection for the coordinated evolutionary development of air navigation for international civil aviation, the special committee developed a system concept, based largely on satellites, for CNS and for the evolution of air traffic management, generally referred to as ATM. The new CNS/ATM concept is intended to gradually implement satellite technology while building on the existing CNS system and technologies without making them obsolete, at least not in the short term. It offers improvements that can be implemented through an evolutionary transition on a local scale, as requirements dictate, while meeting the need for global coordination. In general, the CNS/ATM concept allows for a judicious mix of satellite technology and the best of line-of-sight systems to achieve an overall optimum result.

## G. Planetary exploration and astronomy

45. The Space Research Institute of the Austrian Academy of Sciences at Graz is involved in several major scientific spacecraft missions. The four-spacecraft mission Cluster is carried out jointly by ESA and NASA and is aimed at probing the Earth's plasma environment with four identical spacecraft on almost identical orbits. Its primary scientific objectives lie in the analysis of boundary layers and wave fields in the plasma environment near the Earth in three dimensions. The mission Interball consists of two pairs of satellites, one in a fairly low orbit (apogee 20,000 km) and the other with an apogee of 200,000 km. These two very different orbits were chosen in order to cover the auroral and the tail regions of the Earth's magnetosphere, respectively. Each of these large satellites will be accompanied by a small subsatellite (built in the Czech Republic with experiments from Austria, France, Germany, Poland, Romania, Russian Federation and Slovakia), in order to allow differentiation between spatial and temporal effects.

## H. Space medicine

46. The Austrian Society for Aerospace Medicine (ASM) was established in 1991, following the successful completion of the joint Austro-Russian Space Project AUSTROMIR. The Society is comprised of the ASM Institute for Space Neurology, ASM Institute for Adaptational and Space Flight Physiology, ASM Institute for Space Exercise and Physiology, ASM Institute for Space Dosimetry and ASM Institute for Space Qualification and Testing. Due to the successful cooperation in the field of space medicine between Austria and the Russian Federation during the AUSTROMIR project and the positive relationships that were established between the scientific personnel on both sides, ASM was invited to fly improved versions of the successful medical experiments from the AUSTROMIR project on the long-duration Mir Station missions.

47. As part of the Russian National Space Programme, the Russian physician cosmonaut Valery V. Polyakov lifted off from Baikonur on 8 January 1994 with the crew of Soyuz TM-18 to investigate the effects of long-term spaceflight, especially weightlessness, on the human body. Dr. Polyakov was scheduled to remain on board the Space Station Mir for a period of at least 14 months, breaking the space endurance record. The Russian Long-term Flight (RLF) project, using Austrian technology, is viewed as an important milestone in the foreseen future project to Mars. The scientific/medical part of the complete RLF project is managed, controlled and coordinated by the Institute of Bio-Medical Problems (IMBP), based in Moscow.

48. The use of the experiments by a number of cosmonauts, over a substantial period of time, will lead to a large quantity of data which should provide important insights with respect to the effects of long duration space stay. This data will also be used as a spin-off to ascertain certain basic knowledge with respect to the functioning of the human body, its central nervous system and the development of new diagnostic and therapeutical concepts that may be used in normal everyday medicine. Using the crew medical examinations

taken before, during and after each flight, as well as the medical information from the control subjects on Earth, it will be possible to determine the degree of change that the effects of long duration space flight have on the human body.

### *Notes*

[1] *Official Records of the General Assembly, Forty-ninth Session, Supplement No. 20* (A/49/20), para. 101.

*Annex**

# SCIENTIFIC AND TECHNICAL PRESENTATIONS TO THE SCIENTIFIC AND TECHNICAL SUBCOMMITTEE AT ITS THIRTY-SECOND SESSION

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*This annex has not been formally edited.

# I. SYMPOSIUM ON APPLICATIONS OF SPACE TECHNOLOGY FOR EDUCATION

## A. Space Technology to Improve Education and Health Care Services

1. Despite global recognition that health and education are the essential building blocks of a sustainable society, serious shortcomings and unequal distribution in education and health care services remain. A recent study estimated that two billion people have either minimal access to basic education or health care, or are completely lacking access to these services.

2. Limited access to educational and health care services is generally driven by complex economic, political, social and cultural factors. A single technological project alone cannot hope to resolve such vast and complex shortcomings. It has, however, been demonstrated that technology can improve the situation. Modern telecommunications technology has the potential to play an important role in this situation, in particular given its ability to reach many people at a reasonable cost.

3. Satellite communication plays a very significant role in distance education. Many developing countries cover large geographical areas and have sparsely distributed populations. Transportation in remote areas, mountain regions, islands and deserts is poor and communication links are hard to establish. The limited availability of resources in many developing countries does not permit establishment of the costly infrastructure needed to meet developmental needs. Thus, satellite communications is probably the only way to educate people in rural areas and difficult geographical locations.

4. Tele-education and tele-health involve the use of telecommunication techniques to provide educational or medical services over long distances. Common examples are the use of satellite television to teach students in remote areas, or of a doctor in a remote area transmitting an X-ray image to a specialist thousands of kilometres away for consultation.

5. Space education should not be concentrated around satellite communications, there are also considerable contributions to be made by Earth observation satellites, providing a very relevant vehicle for many future programmes. Other space activities, space science, microgravity etc., all have some educational components which should not be overlooked.

## B. Global Access to Tele-health and Education Systems

6. In an effort to address the globally unbalanced provision of educational and medical services, participants in the International Space University's (ISU) 1994 summer session proposed the creation of a Global Access Tele-health and Education System (GATES). By using advanced communications and information technologies for tele-health and tele-education applications, GATES aims to improve basic education and medical care on a global scale.

7. The goal of the GATES project is to reduce "inequalities in health and education within countries and between countries by providing global access to health care and educational services using telecommunications technology". The unique aspects of the proposed GATES system are that it takes a global approach and it has the dual objective of combining education and health care. This dual approach is justified by the fact that the highest educational and medical needs generally appear in the same areas. Furthermore, the basic communications requirements for educational and health care services are very similar.

8. A global strategy was justified by the worldwide distribution of the shortcomings to be addressed. Financially, a global system can be funded by combining available resources from many sources. This will allow the shared use of the system with regions less able to support high investment costs. Satellite

telecommunications using existing systems in geosynchronous orbit and future proposals in low Earth orbit (LEO) ensure the technical feasibility of the project and offer coverage of a global nature.

9. The potential users of GATES can be divided into three categories: specialists, non-specialists and beneficiaries. A specialist is typically a medical doctor with expertise in a specific field of medicine, or a specialized teacher. The non-specialist is generally a doctor, a nurse or a teacher who is working in a remote area. The beneficiary is the patient or the student who receives the medical or educational service.

10. For the user to accept a global system, it is important that the actual information or content of the transmitted message is not defined centrally. It must be managed regionally or even locally to fit the culture and priorities of the region. The telecommunication links must reach the user even in remote areas and regions lacking a communications infrastructure. Furthermore, it must allow a sufficient flow of information to fit the application. This is generally limited by the bandwidth of the link. The required data rate varies with the level of service to be provided but it appears that many basic services can be provided via narrowband links. The evolution of data compression techniques, reducing the required data without major loss of quality, further increases the capabilities of limited bandwidth applications. A reasonable minimum service offering two-way voice communication, data transmission (e-mail, fax) and still-image transmission capability is feasible with less than 64 kbit/s per channel. More advanced applications such as video conferencing or compressed video require minimum data rates in the range of 384 kbit/s to 6.3 Mbit/s, respectively.

11. A technology review was carried out to identify the most adequate technical solution for GATES. Communication standards, analog and digital networks, wire and microwave ground systems, and existing and planned satellite systems were examined. It was found that although terrestrial telecommunication systems offer high capacity at decreasing cost in densely populated areas, they are not cost effective in remote areas where the population density is lower. In the absence of terrestrial networks, satellite systems were found to be the most effective way of providing the necessary communication links.

12. An investigation of 20 existing satellite systems showed that global coverage with identical ground terminals could most easily be achieved using C-band frequencies. The geostationary C-band solution is a low-risk choice based on proven technology that provides acceptable performance for part of the required applications. The cost of the existing systems solution greatly depends on the negotiation of the service charges. It is hoped that non-commercial rates would be applied, considering the international and humanitarian characteristics of the application.

13. The design is based on eight 600 kg satellites equally distributed in a circular equatorial orbit (zero degrees inclination) at an altitude of 8,000 km. In addition, four smaller satellites will be placed in a polar orbit at the same altitude. The equatorial segment will provide continuous service to the area between 55° North and 55° South latitudes, which is where the majority of the world's population lives. The polar segment will provide an extension to continuous global coverage. High elevation angles, enabling more compact and cheaper ground terminals, will be offered in the area between 30° North and 30° South latitudes, where most developing countries are found.

14. In addition to global education and health care services, the establishment of a system such as GATES has the potential to contribute significantly to other applications. There can be direct benefits for disaster and emergency applications as well as for addressing environmental issues. In the domain of environmental protection, GATES can be a unique tool to foster environmental education and collect environmental data. Collaboration with other projects such as the Global Learning and Observation to Benefit the Environment (GLOBE) programme (see below) would be directly applicable.

## C. Space Education Projects in the United States

15. In the United States, the Global Learning and Observation to Benefit the Environment (GLOBE) programme was proposed in 1994 to bring school children, teachers, and scientists from around the world together to enhance environmental awareness of individuals worldwide, increase scientific understanding of the Earth and support higher standards in science and mathematics education. The GLOBE programme combines the use of comprehensive environmental educational materials with the opportunity for students to conduct hands-on science projects. Educational materials have been developed and, where possible, adapted from existing environmental education materials by environmental educators and curriculum development specialists.

16. The GLOBE educational materials include a teacher's guide with age-appropriate materials explaining the programme and also includes procedures for environmental measurements and provides broad information about environmental topics. The materials also include student worksheets that will assist students in making measurements and reporting their data. Any other environmental education materials that may be useful, including information accessible through the Internet, will also be identified.

17. An invitation for schools to apply to become GLOBE schools was issued, resulting in thousands of responses. All schools willing and able to participate in the programme may become GLOBE schools. Many of these schools have the necessary resources and funding to purchase scientific instruments. Some government assistance will be available to assist schools selected through a competitive process. Internationally, each participating country is responsible for selecting its participating schools.

18. GLOBE schools worldwide will make a specific set of environmental measurements in the following areas: atmosphere/climate, hydrology/water chemistry, and biology/geology. Each school will be encouraged to coordinate its activities with those of other neighbouring schools. Specifications for measurement instruments have been developed and known sources of instruments identified to assist the acquisition of school instruments.

19. Instructional elements of GLOBE educational materials related to the environmental measurement procedures and data reporting protocols will be translated into the six official United Nations languages. Other environmental education materials will be provided in English. Each partner country will name a Country Coordinator who will be responsible for day-to-day management, oversight, and facilitation of that country's GLOBE programme. The coordinator will also be responsible for adapting, translating, reproducing, and distributing educational materials to that nation's GLOBE school.

20. Broad international participation is integral to the design of the GLOBE programme and to the achievement of its goals. Therefore, the programme seeks international participation by countries throughout the world. Bilateral agreements between the United States and partner nations will specify the roles and responsibilities of the partners. International agreements will provide for long-term, durable partnerships based on the concept of mutual benefit. Cooperation will be conducted on a no-exchange-of-funds basis, with the international partners responsible for acquiring the resources necessary to equip their schools to conduct the activities of the programme.

21. The GLOBE programme will be managed as an interagency effort led by the National Oceanic and Atmospheric Administration (NOAA). Other agencies involved in the programme are the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), the Environmental Protection Agency (EPA), the Departments of Education and State, the Council on Environmental Quality (CEQ), and the Office of Science and Technology Policy (OSTP). In addition, a private sector partner will be selected to assist in supporting substantial growth of the programme.

22. NASA's educational programmes, developed and managed by the Education Division, uses unique facilities and laboratories, supporting more than 300 local, regional, and national programmes. In addition to national programmes run from NASA headquarters, field centres manage a number of education programmes that are designed to reach out to the educational community that is in close geographic proximity to that centre to meet local needs.

23. NASA's education vision is to promote excellence in America's education system through enhancing and expanding scientific and technological competence. In this context, NASA's unique missions and results will be used to capture and channel student interests in science, mathematics and technology, as well as to enhance teacher and faculty knowledge and skills related to these subjects. Programmes will be developed at all educational levels. Students and faculty will have the opportunity to participate in NASA-sponsored research activities at NASA field centres.

24. The concrete working plans will be guided by national curriculum standards, state curriculum frameworks and local education agency needs. Examples include the "Summer High School Apprenticeship Research Program" (SHARP), involving more than 400 minority high school students, and the "Graduate Student Researchers Program", providing support to train students in NASA related disciplines at both the master's and the doctoral levels. Teacher workshops will play a significant role in ensuring that students and educators alike are provided today with the tools they will need tomorrow. A major element of these programmes is the development, utilization and dissemination of instructional materials in the fields of mathematics, science and technology.

25. In connection with its space education programme, NASA is cooperating with the Aerospace Education Alliance, which is a cooperative venture of five leading United States aerospace education organizations: U.S. Space Foundation, Young Astronaut Council, Challenger Center for Space Science Education, U.S. Space Camp and Space Academy, and Astronaut Memorial Foundation. By working together and using space as a unifying and inspiring educational theme, the alliance will implement a coordinated strategy to support to enhance America's teaching process.

### D. The Canadian Environmental Education Centre

26. The Canadian Fort Whyte Centre for Environmental Education in Winnipeg is designed to carry the message of interdependence to 50,000 school students and adults annually. Located on a reclaimed clay quarry, the Centre is spread over 200 acres of forest, lakes and self-guiding trails.

27. From kindergarten to high school, over 35,000 students annually participate in the Centre's school and youth group programmes. School programmes are offered in both English and French. Natural history subjects provide a basic understanding of local and global ecosystems, while sustainable living programmes provide insight into personal environmental impacts of every day life.

28. Public programmes at the Centre are designed to inspire families and individuals with appreciation for our natural world. Seminars, hands-on workshops and recreational activities are offered throughout all seasons. These programmes inspire concern for the health of the environment, and subsequently, action to ensure preservation of natural assets. Although the majority of the Centre's educational programming takes place on site, there is a growing demand for off-site presentations as well.

29. Private sector donations and fundraising events represent over one-third of total revenue. Business and individuals are partners in environmental education through special programmes such as the "Class Act Sponsorship" of school field trips to the Centre and the "Foster Parent Programme" through which donors share the care for resident wildlife. Yearly sponsorships from private foundations and companies support

many of the Centre's major exhibits such as the "Aquarium of the Prairies", the "Waterfowl Display Flock", and the "Touch Museum".

### E. South American Perspectives on the Application of Space Technology for Education

30. Four of South America's largest countries -- Brazil, Peru, Colombia, and Bolivia -- still have illiteracy rates above 10 per cent. In Brazil and Bolivia, which together cover more than 50 per cent of South American territory, illiteracy rates are above 20 per cent, or more than 30 million people.

31. Even with its high illiteracy rates, 22 per cent or 66.27 million South Americans attend primary and secondary levels schools, where they are taught by 2.9 million teachers. Approximately 1.6 per cent or 4.8 million South Americans attend universities and there are more than 300,000 professors. Brazil's territory covers almost 50 per cent of the entire continent and is home to more than 50 per cent of its population. It is the fifth largest country in the world both in terms of geographical area and population. Roughly 50 per cent off South Americans students are Brazilians, but the country still has the region's second highest illiteracy rate.

32. The establishment of solid educational structures in South America is certainly vital to political and economical development, and is a prerequisite for the elimination of poverty and social injustice, and ensuring the region's place in the global economy. But, public investment in education is quite low, especially considering that most South American families cannot afford to pay for private schools and universities to educate their children.

33. Brazil has some geographical characteristics such as a large land mass, and inaccessible and sparsely populated territories, that make it very suitable for the use of space technology. One of most significant activities in the field of applied space applied research during the 1960s and 1970s was the Advanced Interdisciplinary Communications Satellite (SACI), the planning of which started in 1968. The central objective of this project was the establishment of a national tele-education system, using direct satellite broadcasting as the means for relaying educational TV programmes to all parts of the country.

34. The SACI project started with the formation of an interdisciplinary group, with about 150 specialists, both Brazilian and from other countries, and with the creation of a master degree course in educational technology. Financial support for the SACI project was obtained from abroad, through the United States Agency for International Development (USAID). In 1973, when the SACI project was underway, there were 18 million illiterate Brazilians out of a population of about 90 million, or an illiteracy rate of 20.1 per cent. Presently there are 30 million illiterate Brazilians from a population of 147 million, and -- the sad conclusion after more than 20 years -- an illiteracy rate of 20.2 per cent.

35. The Ministry of Education (MEC) has been working since 1990 on the establishment of a national distance learning programme, especially dedicated to first and second grade schools. This work has been developed in cooperation with other ministries, universities, private organizations, state secretariats of education, and the Brazilian telecommunications company Embratel. Since 1992, the state TV networks, Fundação Roquete Pinto and Rede Brasil, have broadcast the daily programme "Um Salto para o Futuro" ("A Jump to the Future"), that dedicates one hour to programmes focused on improving teacher capabilities. In 1994, this programme reached more than 140,000 teachers in 26 Brazilian states.

36. Since its creation in 1961, the National Institute for Space Research (INPE) has developed graduate level courses to create a group of space specialists to work on its research and development projects. There were no similar courses in Brazilian universities and INPE was, and still is, the only governmental and civilian space research organization in Brazil. These courses were basically oriented toward space and atmospheric sciences, space meteorology, space engineering and technology, and remote sensing. The preliminary idea

was that these courses would ultimately be transferred to the universities, but some of them are still given at INPE. Since the creation of the Brazilian Space Agency (AEB) in February 1994, there have been discussions on the possibilities of having more graduate courses in space-related disciplines at universities.

37. For the past nine years INPE has been offering an international specialization course on remote sensing, in cooperation with the United Nations University (UNU), the United Nations Office for Outer Space Affairs (OOSA), the Ministries of Education and Science and Technology, and the European Space Agency (ESA). Since 1985 the course has had 59 participants from Latin America and Africa. Presently the course is being offered only to Latin American participants. The main objective of the course is to give capacity to specialists from developing countries on the techniques and methodologies of remote sensing for the study and monitoring of natural resources.

38. The experience acquired with these graduate and training courses, and space application projects since 1970 were a significant factor in the selection of INPE to be one of the two sites (the other is in Mexico) for the establishment of the first United Nations Centre for Space Science and Technology Education. The establishment of the United Nations Centre for Space Science and Technology Education in Latin America and the Caribbean is a chance that cannot be lost for the implementation of a serious and competent work on the diffusion of space science, technology and applications in Latin America. The Centre can open up the possibility of making real use of space science and technology as an essential instrument to understand and monitor this part of the globe, that still has so many areas unoccupied by human beings.

39. Besides the strictly educational purpose of the Centre, it can also play another important role by educating the general public and promoting public understanding of space. The citizens in the new democracies of South America are just beginning to get used to the fact that they have rights, and that they can have strong influence on the destiny of their countries. In the past, the Brazilian space programme was organized and run by the military with no participation of other social, political, and economic groups that could be involved with it. The National Congress was also not involved in these decisions. Today, more and more governmental decisions are taking public opinion into consideration. The public therefore must be well informed about the social and economic benefits of space technology so that it can influence its representatives in the Congress about space programmes and activities that are of real interest to society and the country as a whole.

### F. The Indian Experience in Applications of Space Technology for Education

40. In India, education is considered as an integral part of the country's development process and thus has been accorded a high priority. Consistent with the application-driven approach adopted from the very beginning of the Indian space programme, sincere attempts have been made to utilize the latest developments in communications technology to realize national educational goals. Today, the utilization of the Indian National Satellite (INSAT) system in meeting the educational requirements is acclaimed and well accepted all over the country. The INSAT system is being efficiently utilized for a number of applications such as educational TV programmes, interactive training programmes and mass communication programmes to various target groups. Efforts are underway to fully harness space capabilities for not only meeting the country's educational needs but also to ensure that it becomes the carrier of information and awareness to the predominantly rural population of India.

41. The inevitable role of modern communications technology in fulfilling the task ahead in the educational sector is well reflected in the National Policy on Education (NPE). Apart from a general improvement in the telecommunications infrastructure to which the satellite system has contributed substantially, significant progress has been made in harnessing the potentials of space systems for educational applications. In view of the expansion of broadcasting facilities with the advent of INSAT and accompanying demand for educational software, the Ministry of Education has prepared a scheme for making Educational Televi-

sion (ETV) programmes by establishing a Central Institute of Educational Technology (CIET) and six State Institutes of Educational Technology (SIETS). The satellite-based ETV service presently provides educational programmes of 45 minutes duration in each of the five regional languages, telecast on a time sharing basis.

42. The experimentation programme with a one-way video, two-way audio configuration has also yielded insights into the systems and the technical and economic aspects of designing, implementing and operating such a system on a regular basis. The software elements are largely dependent on the nature of the user group and therefore need to be tailored to the specific context of the user groups. With its long experience in the technical and applications aspects of satellite communications and broadcasting, ISRO is in a position to provide assistance to potential users who plan to set up an interactive satellite broadcasting network for education or training.

43. Convinced of the capabilities of communications satellites in distance education and eradication of illiteracy, particularly among the rural masses, ISRO is working on a new concept of a dedicated satellite mission. his aims at utilizing the most powerful audio-visual medium using dedicated "GRAMSAT" satellites, which will be specifically tailored to meet the basic requirements of rural areas to disseminate culture and region specific knowledge on health, hygiene, environment, family planning and better agricultural practices in each of the regional languages.

44. The GRAMSAT satellite concept includes six-to-eight high-powered C-band transponders which together with video compression techniques can disseminate region and culture specific audio-visual programmes in each of the regional languages. The high power C-band transmission will also enable linguistic minorities in other States to receive programmes in a language of their choice in a direct reception mode, requiring an antenna of only 2 metres.

45. The educational background as well as the learning contexts of the participants have varied widely, covering adult education, open education, continuing education for professionals and "enrichment" education for college students. According to the evaluation studies carried out by ISRO, the pedagogic effectiveness of tele-teaching have been proven beyond a doubt. The multiplier effect of satellite broadcasting technology and the increased coverage of the target population, the repeatability of training courses and educational packages, and the significant savings in expenditures regarding travel, logistics and replication of teaching infrastructure are among the most evident advantages of these tele-teaching programmes.

46. In order to meet the manpower requirements needed for taking up the future challenges, considerable efforts have been made to establish necessary facilities for providing education and training in space technology development and its applications. The Standing Committee on Technology and Training of the National Natural Resources Management System (NNRMS) oversees the training activities at national level. In addition, a number of universities and institutions offer education and training opportunities. The duration of these training programmes for decision-makers, supervisory officers and scientists, vary from several days to several months, depending on the requirements.

47. Efforts are also underway to introduce space education in the educational curriculum of India. A number of training programmes on various themes for university and school teachers are organized on a routine basis. A curriculum development report detailing the syllabus and highlighting various aspects of introducing space education in the curriculum has been brought out jointly by the University Grants Commission (UGC) and the Department of Space (DOS).

## G. Other Relevant National Space Education Activities

48. French experience with space education was substantially enhanced in 1974, when the technical facilities of the French space agency CNES were moved from Brétigny sur Orge to Toulouse. It allowed for close cooperation with Université Paul Sabatier, Ecole Supériere de l'Aéronautique et de l'Espace, ONERA, the research laboratories of CNES and aerospace industries already located there. Each year, about 200 specialists from CNES give almost 3,000 hours of lectures in aerospace technology, electronics, automatization, natural sciences, telecommunications, remote sensing, management of large projects, etc.

49. Since its creation in 1962, CNES has paid great attention to the education of youth in the field of space applications. One activity is the organization of summer schools on particular subjects and support of youth clubs. One of the most favorite club activities is the launching of balloons and model rockets. Small rockets can be used by children over 8 years old and, experimental rockets launched by those older than 15 can deliver payloads of up to 30 kilogrammes to an altitude of 6,000 metres. CNES provides the overall guidance for these activities, provides professional rocket engines and is responsible for safety. Teenagers are also involved in the launchings of meteorological and stratospheric balloons.

50. There are usually special stands at different expositions, where young people can get interesting information related to current space activities and applications. At the university level, education on space technology is provided on a broad basis. Lectures on the fundamentals of remote sensing are provided at the Université de Paris VII and the Université d'Aix en Provence. They provide diplomas in "space technology" at the doctoral level. The Conservatoire National des Arts et Métiers in Paris, an important institution of higher education, has a Chair of Space Programmes and Technology.

51. In 1993, the Groupement pour le Développement de la Télédétection Aérospatiale (GDTA, founded in 1973 by CNES and Institut Géographique National), held courses for more than 500 trainees. A high proportion of these trainees come from Central and Eastern European countries. All GDTA courses place great emphasis on the use of satellite data in GIS and involve a substantial amount of practical work.

52. There was also sustained training abroad, with seminars in Algeria, Argentina, Burkina Faso, Chile, Kenya, Mexico and Thailand. Furthermore, GDTA has experts permanently seconded to training centres in Africa, South-East Asia and South America. A great effort was made to draw up educational files, about 1,500 copies of which were distributed in 1993. These files are currently issued in French and English, but were also scheduled to be issued in Spanish as of 1994. GDTA activities to initiate school children to remote sensing were greatly extended in 1993, with GDTA remaining in contact with over 400 educational establishments in France.

53. The German Remote Sensing Data Centre (DFD) of the German Aerospace Research Establishment (DLR) has developed and operates the Intelligent Satellite Data Information System (ISIS) as the central user interface of its Data and Information System. The major objectives of ISIS are to supply a broad user community with relevant information for the assessment and selection of appropriate remote sensing data, and to enable access to the respective archives for the acquisition of data.

54. In the context of future international programmes on Earth observation using multisensoral data from space missions such as EOS and ENVISAT, it is of considerable importance to provide for the archiving of data and research results as well as for the effective distribution of the information to the multidisciplinary users. The archive will be part of the future Global Environmental Data Network of the space agencies. Based on the experience gained both in the course of the development of ISIS, and also from user response, ISIS has reached the operational status of being the central national point of access to remote sensing data, and has become a valuable tool for international users.

55. In Israel, a process has been initiated to improve the quality and expand the availability of space science and engineering education at the collegiate level by compiling a baseline set of information on activities related to space science and engineering at institutions of higher education. As space research is usually multidisciplinary, the teaching of most space research areas is included within the framework of existing disciplinary courses. As an example, planetology has fundamentally altered our understanding of atmospheric physics and chemistry. However, space research results impact many teaching areas to different degrees. In some disciplines, such as astronomy and astrophysics, the impact of space research results have been so basic and extensive as to change the discipline in a fundamental fashion.

56. One of the most important initiatives in this direction was a series of the educational "Lectures from Space" performed in 1993 by the crew of the orbital station Mir, cosmonauts V. Tsibliyev and A. Serebrov. It was inspired by the idea of the space educational programme intended for Christa McAuliffe, which did not occur due to the tragic incident of the space shuttle Challenger in 1986. The developer of the Russian project is cosmonaut A. Serebrov, who, together with A. Viktorenko, commander of the fifth main crew of the Mir station, performed three space-borne lectures on ecology, microgravity physics, biology, medicine and geography at the end of 1989 and the beginning of 1990. The project has been recently continued by the 15th and 17th Mir station crews. This project is conducted in cooperation with specialists from the Flight Control Centre near Moscow and coordinated with the national education programme by the Ministry of Education of the Russian Federation and the Soyuz national aerospace club.

57. For the first time, the unique conditions of orbital flight at the permanent space station Mir are being utilized for performing educational experiments in physics, chemistry, geography, biology, medicine and even physical exercise. Lectures are now prepared by specialists from the Academy of Sciences and other institutions. Lectures have been transmitted to pupils and students in approximately 50 towns and villages of the former Soviet Union, as well as to 20 other countries. In the future, a series of audio-visual materials will be prepared for inclusion in regular educational programmes in different disciplines. Some experimental programmes have already been tested with encouraging results. In the future, this experience could be used in broader international cooperation for real-time transmission via satellite into remote areas.

## H. The Role of UNESCO in Space Education Programmes

58. The United Nations Educational, Scientific, and Cultural Organization (UNESCO) has developed expertise in space applications independently or in cooperation with other United Nations bodies, space agencies or scientific institutions. As the mandate of UNESCO is related to the fields of education, science, culture and communications, the space activities of UNESCO are related to each of these four domains.

59. In the education sector, UNESCO cooperates to produce distance learning modules to reach large target audiences dispersed over vast geographical areas. Through UNESCO's worldwide network of integrated schools, innovative teaching materials for secondary schools will be used. Through UNESCO consultancy missions, Member States can obtain advice in the planning for long-term investment and development in cost-effective education.

60. UNESCO also plays a vital role in the scientific sector. Space activities are related to the implementation of international programmes in ecology, hydrology, marine science, oceanography and geology. In the field of ecology, UNESCO uses remote sensing systems to improve the management of more than 400 biosphere reserves, created worldwide in the framework of its "Man and Biosphere Programme".

61. In the field of hydrology, remote sensing and Geographical Information System (GIS) are used to improve the integrated use of surface and ground water. Better management of water resources is urgently needed in view of the growing population and the ever increasing concentration of people in "megacities" which often lack adequate water resources.

62. The study of natural hazards through geology and geophysics programmes is part of UNESCO's contribution to the International Decade of Natural Disaster Reduction (IDNDR). UNESCO recently presented its programmes on the development of new methodologies using space data to assist developing countries in their preparedness to mitigate the effects of natural hazards. In Latin America, UNESCO organized a number of research projects for development of cost-effective methods for landslide monitoring by using GIS data from advanced space-borne sensors such as Landsat TM, SPOT, and the ERS series.

63. The EURISY Workshop on "Distance Learning and Environmental Awareness - the Role of Satellites" was held in Frascati, Italy from 21 to 23 September 1994 with the active support of Telespazio, the European Space Agency (ESA), the European Space Research Institute (ESRIN) and UNESCO. The aim of the Workshop was to enable teaching, telecommunications and Earth observation specialists to present new technologies and to consider how they could develop experience and explore ways to encourage the use of distance learning methods, in particular with regard to the environment. This successful event brought together 100 specialists from Europe, the United States, Africa, Latin America and Asia. The conclusions and recommendations of this Workshop provided important insight into these new fields.

64. In the near future, UNESCO will launch additional projects on the development of new methodologies for the reduction of natural hazards. These projects will be organized in Asia and will include studies of mudflows and volcanic activities. It is anticipated that as in the past, these projects will profit from the active support of international, regional and national space agencies. UNESCO is also aware of the increasing need for professionals such as engineers, scientists and resource managers to continuously upgrade their skills through training courses. In order to assist in this process, the organization is currently developing interactive software packages.

## II. OTHER SCIENTIFIC AND TECHNICAL PRESENTATIONS

### A. Measurements of Space Debris

65. Objects moving in near-Earth orbit are tracked and catalogued by the United States Space Command Space Surveillance System. This system operates more than 24 radar and optical facilities to monitor near-Earth space and maintains a catalogue of orbital elements of all tracked objects. The minimum diameter of observable objects is about 10 cm in LEO and 1 m for the geostationary orbit (GSO). The catalogued objects represent about 99 per cent of the total on-orbit mass (roughly 3,000 metric tons) but only 5 to 20 per cent of the debris larger than 1 cm. The number of debris in the 1-10 cm range is estimated to be between 35,000 and 150,000, and the population of particles larger than 1 mm is probably more than 1,000 times the catalogued population.

66. In the past year, 89 successful launches into outer space have been carried out (compared to 79 in 1993). The total number of trackable objects in space is steadily increasing (7,860 at the end of 1994). More than 40 per cent are fragments of rocket upper stages and spacecraft as a result of explosion. As of the end of 1994, 124 known breakups have occurred. Only about six per cent of the catalogued objects are operational spacecraft. In 1994, six new fragmentations were observed:

a) 7 February 1994, Titan IIG stage (international designation 1994-004B), orbit 220 x 254 km, 745 fragments were registered, but decayed by now;
b) 27 April 1994, Ariane 4 third stage (1991-015C), GTO orbit, 9 fragments;
c) 7 May 1994, Proton kickstage (1991-010D), orbit 225 x 21805 km, 39 fragments;
d) 6-8 November 1994, Proton stage (1992-047H), orbit 479 x 19033 km, 36 fragments;
e) November 1994, USA 40 satellite (1989-061A), 62 fragments; and
f) 26 December 1994, Russian Rokot stage (1994-085B), 1865 x 2185 km, 30 fragments.

67. Europe is making a significant contribution to the expansion of knowledge of small-size particles with ESA's European Retrievable Carrier (EURECA), the returned solar array panel of the Hubble Space Telescope (HST) and other spacecraft. The spacecraft surfaces are covered with a large number of impacts of micrometeoroids and debris. The size of individual impact craters and holes range from 20 microns to several millimeters. A preliminary analysis of EURECA shows that the number of large impacts was greater than expected. The first visual inspection of the retrieved panel revealed a large number of impacts, with the largest hole roughly 2-3 mm in diameter. The results from the EURECA and HST panel impact analyses will be used to validate current reference flux models for small size meteoroids and space debris.

68. A 24-hour measurement campaign in LEO with facilities located in Europe was carried out on 13-14 December 1994. The radar stations involved were in Wachtberg-Werthhoven (Germany) and Fylingdales (United Kingdom), Herstmonceux (United Kingdom) and Zimmerwald (Switzerland). The purpose of the campaign was to observe a specific volume in space, detect all objects of a minimum size passing through that volume, and compare results with predictions by a space debris model. Preliminary analysis of a limited amount of data within 19 hours resulted in 26 detections of such objects. Similar campaigns carried out with the Haystack radar (United States) show that current space debris models overestimate the number of debris at lower altitude (300 - 500 km), while at higher altitude (800 - 1,000 km) the number in underestimated.

69. The German radar searched in a volume centered at a range of 785 ± 75 km with a beamwidth of 0.5 degrees, for which ESA's MASTER reference model predicted 84 detections of objects larger than 2 cm. Preliminary analysis of a limited amount of data within 19 hours resulted in 26 detections of such objects. Similar campaigns carried out with the Haystack radar (United States) show that current space debris models overestimate the number of debris at lower altitude (300 - 500 km), while at higher altitude (800 - 1000 km) the number in underestimated.

70. The Synoptic Monitoring of Orbital Debris (SYNMOD) project, carried out by the Institute for Space Science and Technology (ISST Europe) in Grasse Magagnose, France, in collaboration with several laboratories and institutes, is supervised by European and American organizations. The French space agency CNES has been involved in two basic projects focussing on debris in the GSO and in geostationary transfer orbits (GTO):

a) A ground observation programme, with observations conducted with the Calern observatory which uses a telescope fitted with the CCD camera. An observation campaign lasting three months is planned in order to verify whether the observation site and the measuring devices are really suitable; and

b) A detector calibration programme with observations that will be conducted in orbit using a new type of electrostatic detector that can measure the mass and velocity of the particle that has caused the impact. At the beginning of this effort ground experiments will be necessary in order to assess the efficiency of this type of detector.

71. Another project, called ROSACE, is currently under development by CNES. It is intended to improve the determination of geostationary satellite orbits from ground-based observations. The system combines a Newton telescope and a charged couple device (CCD) matrix. The goal is to measure the angular separation between the image of the satellite trajectory and stars with precisely known positions. The timing is provided through a Global Positioning System (GPS) receiver. Measurement accuracy is expected to be 0.1 arc second and 1 ms in time. Integration of the prototype used for this experiment will start in 1995.

## B. Computation of Space Debris Orbits

72. Several strategies, including shielding of the critical components of a spacecraft, can be adopted for protecting a spacecraft from the consequences of orbital debris impacts. However, the only efficient way to avoid collisions of the spacecraft with orbital debris greater than 1 cm in size is to alter the spacecraft's orbit. To achieve this, the spacecraft must be maneuverable and predicted future positions of the spacecraft and space debris must be known with sufficient accuracy. The accuracy requirements of predictions depend on the spacecraft and its maneuverability. Predictions must be sufficiently accurate to avoid false alarms and to provide high confidence of predicted collisions.

73. Space debris pose a significant danger for missions such as the International Space Station, the Hubble Space Telescope or NOAA satellites. The Space Station's large cross section and the anticipated length of its mission magnify significantly the danger of a catastrophic failure. To provide an accurate warning of possible collisions, it is essential to maintain a catalogue of debris orbital elements sets and to calculate precise predicted positions of a large number of objects. The Naval Space Surveillance Center plans to maintain a catalog of 25,000 objects larger than 1 cm in support of the International Space Station. Since the maneuverability of the proposed International Space Station is limited to a few maneuvers per year and at a distance of a few hundred metres, the accuracy of the predicted positions must be very high. In the case of NOAA satellites, the prediction accuracy requirement is 1 km for a three-day prediction.

74. The future positions and velocities of Earth-orbiting objects at a given time are calculated from available orbital elements or positions and velocities at the initial "epoch" using either analytical or numerical theories of motion and taking into account an appropriate force model. The accuracy of the predicted positions is a function of the:

a) accuracy of initial conditions, i.e. orbital elements at the epoch, which are derived from observations and depend on the accuracy of radar and optical observations and orbit determination methodology;
b) the accuracy of the adopted theory of motion;
c) the adopted model of forces and its accuracy; and
d) the time interval elapsed from the epoch of elements (accuracy usually decreases with the square of the elapsed time).

75. Of many factors perturbing orbits of Earth-orbiting debris, the Earth's gravity is the most important and the most complicated. The gravitational potential of the Earth is described by the formula which has a form of a series of so-called zonal (depending on geocentric latitude) and tesseral (depending also on longitude) harmonic terms. Numerical coefficients of this series, as well as the mean equatorial radius of the Earth and the gravitational parameter of the Earth constitute the Earth gravity model.

76. Contemporary models of the Earth's gravity field are derived from many years of precise observations of many artificial satellites and have been produced by NASA Goddard Space Flight Center (NASA/GSFC, Greenbelt), University of Texas (UT), Ohio State University (OSU) in the United States; and GeoForschungZentrum (GFZ, Potsdam, Germany) and Groupe de Reserche de Geodesie Spatiale (GRGS, Toulouse, France).

77. Although new models provide increasingly better descriptions of the Earth's gravity, their accuracy is limited. Using the contemporary models, one can fit the orbit of a geodetic satellite, such as LAGEOS, to precise satellite laser ranging data with the accuracy of centimetres. However, such precision cannot be reached in the calculation of the predicted positions of other Earth-orbiting objects.

78. Uncertainties in predicted positions due to the uncertainties in the Earth's gravity model can be estimated using different calculation techniques. At the Astronomical Observatory of the Poznan University (Poland),

the theories and computer programmes have been developed which enable computation of very precise predicted positions of artificial Earth satellites. Using these computer programmes, the predicted positions of satellites at the given time can be computed by applying different models of the Earth gravity field and then compared. Resulting differences are an estimation of the prediction accuracy of a collision between the spacecraft and debris. For the Space Station orbit (400 km altitude, 28.5° inclination), they are 233 m after 24 hours and 751 m after 10 days.

79. In the precise orbit calculations, all coefficients of the applied Earth gravity model must be taken into account. Because contemporary models include many thousand coefficients (e.g. more than five thousand in the case of JGM-2 from NASA/GSFC), algorithms for such calculations are complex and time consuming. In practice, algorithms used to predict future positions of orbiting objects include only a certain subset of coefficients. For example, the SPG4 algorithm used by the United States Space Command includes only three zonal harmonic coefficients. The use of such algorithms limits the accuracy of predictions. It can be estimated, that the use of the SPG4 algorithm introduces a 2,000 m error in the predicted position of the Space Station in any 24 hour interval. The algorithm, including all zonal and tesseral harmonic coefficients up to 10 degrees and on the order of 117 coefficients, involves an error of 765 m in the same case. To be effective, the algorithms for predictions of collision of the Space Station and debris must include a great number of geopotential coefficients. Computer speed is also important because the predicted positions must be calculated simultaneously for a large number of objects.

## C. Modelling of the Space Debris Environment

80. The average relative velocity between any particular spacecraft orbiting in near-Earth space and orbital debris ranges from about 10 km/s for low inclination spacecraft orbits, to about 13 km/sec for near-polar orbits. Due to their great kinetic energy, particles larger than 0.1 mm can cause damage to a spacecraft and a 1 cm fragment has sufficient energy to disturb significantly any satellite's operation. Debris in the 1-10 cm size range (too small to be detected by ground systems) are large enough to cause catastrophic damage to many satellites.

81. The University of Southampton (United Kingdom) continues to develop its expertise in short-term risk modelling of space debris environment. This modelling approach has been applied to investigate constellations of satellites. The United Kingdom Defence Research Agency (DRA), which acts as a national technical advisory service to groups new to this field, continues to build its experience in predicting orbital lifetime and re-entry of debris objects. More recently, it has considered the phenomenon of aerodynamic heating in an attempt to predict the re-entry state of debris as it returns to the Earth's atmosphere and the effects of satellite breakup and debris impingement on a number of satellite systems, including the breakup of one of a family of constellation satellites. The study concluded that the short-term collision risk following a satellite breakup in a modest-sized constellation was low, but may ultimately increase to significant levels.

82. Besides the artificial objects in the near-Earth space, there is also an important natural phenomenon to consider, namely meteoroids, many of which range in size from a fraction of a micron to millimetres. Meteoroids cross the Earth's orbit at very high velocities, on average 2-3 times the velocity of the objects in LEO. In France, a study aimed at analyzing and modelling the directivity of meteorite flux in the terrestrial and interplanetary environment is being prepared, because existing models based on experimental results do not provide information on the direction of the impact. The problem will be dealt with by considering the particles not as independent objects, but as a group with a density that can be approached by mathematical modelling. A second stage will be necessary to optimize this theoretical approach by comparison with available experimental data.

83. The spatial density of debris is quite pronounced in the Indian Remote Sensing (IRS) satellite's altitude band of 800-1,000 km. This altitude band has a low rate of orbital decay and therefore debris have a

protracted lifetime in these orbits. To assess the possible risk to active spacecraft in this band, Indian specialists have developed an analytical model of the trackable debris, characterizing the debris with its mass, size and orbital information. This model, which lends itself to extension to the untrackable region, has been developed at ISRO headquarters in Bangalore. It compares very well with experimental findings and is an improvement over other existing models for space debris characterization at a given altitude belt.

### D. Environmental Protection of the Geostationary Orbit

84. According to the International Telecommunications Union (ITU), there are about 322 active and derelict spacecraft and 111 rocket bodies and other associated objects in the GSO region (data as of October 1991). Most of these objects are no longer subject to active control by their original operators. In addition to the population of objects in the GSO region, there are other objects that transit the region periodically. Some are geosynchronous transfer orbit stages with their perigee in LEO but others are objects that have been displaced to storage orbits above or below the GSO. Operators of geostationary assets have used significantly differing orbital control strategies and these have changed over time. Many orbits have significant degrees of ellipticity; and a recent change in the relevant ITU Radiocommunications Bureau rule of procedure allows significant degree of excursion in inclination. These have all been permissible strategies but the effect has been to expand the effective dimensions of the region characterized as the GSO. For purposes of considering environmental measures, the GSO may be defined as the mean Earth radius of 42 164 km ± 300 km and extending to 15 degrees on both sides of the equator (which corresponds to a distance of approximately 10,000 km). These dimensions are dictated by the initial conditions at loss of control of the spacecraft and the influence of lunar and solar perturbations, solar pressure and the tesseral terms of the Earth's gravity field.

85. Knowledge of the geostationary environment is limited by the resolution of Earth-based observations (about 1 m for the GSO). Risk to operational spacecraft derives primarily from explosion, debris fragments attributable to residual propellants and gases in rocket bodies and, less frequently, to stored energy in batteries. There have been two events that have been characterized as explosions in the GSO. It is quite likely that there have been other events that have escaped detection due to the limitations of observation methods. Because of the past practices of satellite operators, there is significant density in the GSO. However, because this density migrates predominantly in a single direction and the velocities are relatively low, the collision hazard probability is quite modest. While a collision in the GSO will not have the same extreme consequences of those in LEO, they can nevertheless be significant. The velocities are more than high enough to inflict significant damage if the coupling efficiency exceeds a few tens of per cent. At the long-term characteristic collision velocity (500 m/s), the consequences could be comparable to the damage caused by a jet aircraft collision.

86. Boosting the orbit of a satellite near the end of its functional lifetime appears to offer the advantage of reducing the near-term collision probability by some amount. But it is important to note that the same forces that cause migration of the derelict spacecraft in the GSO will perturb the graveyard orbit. In case of an explosion, the resulting debris will accrue different perigee and apogee heights. It is this effect that can place some debris from the graveyard orbit back into a geosynchronous arc. There are also many objects other than spacecraft in the GSO; e.g. apogee kick motors that are normally separated from the spacecraft after circularization in order to reduce the mass and therefore minimize station keeping fuel. It is not clear what advantage there is to re-boosting the spacecraft at the end of life if such objects continue to be added to the population.

87. The requirement for re-boost is 3.64 m/s per 100 km altitude or 1.69 kg of propellant per 1,000 kg of mass of the spacecraft. For each 100 km in elevation above the altitude of the GSO, a westward drift rate of 1.28 degrees per day is induced. Because of the orbital characteristics of the current population in the GSO, the change of perigee altitude should be by 300 km or more and the apogee should be altered by a comparable distance. The mean perigee increase of the objects re-boosted to date is about 250 km.

Definition of an effective minimum altitude is a topic for further study. There is an orbit at 7.3 degrees inclination with zero angle of right ascension that is inertially stable due to the lunar and solar forces. Spacecraft in this orbit would not require north/south station keeping because these forces are in balance. Re-boosting from this orbit is also stable and the risk of collision in the higher altitude is quite small and the contact velocities are very low (5 m/s).

88. If the spacecraft re-boost maneuvers are to have any long-term beneficial effect, they must include measures to preclude explosions. Such debris mitigation procedures have been adopted for all upper stages left in LEO: the residual propellants and pressurants are vented or consumed. Similar action should be effected for objects left in graveyard, geostationary or geosynchronous transfer orbits. Spacecraft debris and rocket stages abandoned in GTO have a low perigee and an apogee at geosynchronous altitude. These debris cross the GSO at least twice a day. The lifetime of the object in GTO depends upon the initial perigee height, the initial longitude of the ascending node and the season of the year. It is possible to select these parameters so that the apogee height will decay rapidly and the transfer stage will not be a hazard to objects in the GSO. However, this constraint on launch windows is often not compatible with other constraints.

## E. Space Debris Mitigation Measures

89. Despite the debris reduction and prevention measures which are currently applied, the mass and total number of space debris are increasing. In order to avoid an unacceptable degradation of the space environment, more efficient measures have to be considered, such as selective de-orbiting of upper stages and spacecraft after mission completion. New developments such as multi-satellite communication systems in LEO are likely to influence the future evolution of the total numbers of objects in space, e.g. the Iridium project with 66 satellites (plus 11 spares) in polar orbits at 765 km altitude, or the Teledesic system with 840 satellites (plus 84 spares) at 700 km altitude.

90. So far, ESA has applied on a voluntary basis several debris prevention and protection measures. They are in the following areas: re-orbiting of geostationary satellites, passivation of the Ariane third stage, reduction of mission-related objects, shielding of manned vehicles. The following geostationary satellites have been re-orbited so far: OTS-2 (orbiting 318 km above GSO), GEOS-2 (260 km), Meteosat-2 (334 km), ECS-2 (335 km) and Olympus-1 (due to a failure, this satellite has been left at orbit 213 km below the GSO).

91. Since flight 59 (in September 1993), all upper stages of Ariane-4 are being freed from residual fuel. Before this flight, this type of passivation was only conducted for launches into LEO. During the operational lifetime of the planned Envisat spacecraft, the creation of mission-related objects will be precluded. At the end of its operational life, pressure vessels and residual fuel will be vented, batteries will be discharged, and the power system will be shut-down. The planned ESA module of the International Space Station will be shielded in order to defeat particles of about 1 cm size.

92. The International Telecommunications Satellite Organization (Intelsat) has adopted the following practices to minimize the creation of space debris:

a) At the end of their operational lifetimes, communication satellites will be boosted into an orbit at least 150 km above the geostationary arc. The intended increase in orbit will be 300 km for the Intelsat-VI and all later series satellites; and

b) Manufacturers of Intelsat spacecraft will be discouraged from using designs that jettison spacecraft parts, especially near the GSO. For example, solid rocket motor casings and solar array cable wraps will stay attached to the spacecraft.

93. The United Kingdom has recognized the unique nature of the geosynchronous altitude and the need to preserve this global resource for future development and exploitation. Consequently, the Skynet family of geosynchronous communications satellites controlled by the United Kingdom have the following operational requirements:

a) For all satellites which are currently in orbit, a fuel budget is allocated which is capable of performing a tri-impulse manoeuvre to a circular orbit with a minimum altitude of 150 km above the geostationary ring at the end of operational life; and

b) Design requirements for future series of satellites specify a capability to achieve a minimum altitude of 500 km above the geostationary ring using a similar tri-impulse manoeuvre at the end of the operational life.

94. For all cases, in order to eliminate the potential for explosion, appropriate operational procedures will be established to render all energetic subsystems passive once the satellite has been placed in a graveyard orbit.

95. In order to limit the impact of debris on future space missions, the current *laissez faire* approach towards spacecraft operations in Earth orbit may need to be superseded by formal controls. The aim of these controls would be to restrict future orbital debris deposition. The processes by which this might be achieved, regulatory or otherwise, are being considered. Two favoured mechanisms are emerging. The first is via self-regulation. This could be based upon interagency agreements, drawing upon guidelines generated within individual agencies to reflect their specific operational requirements. The second approach, international regulation, has more general applicability and would ensure that the responsibility for debris mitigation is borne equally by all users of space. These two approaches are complementary, both seeking the same ultimate objective. The United Kingdom has outlined an environmental management plan based upon the concept of sustainable development. This recognizes the impracticability of zero pollution, and accepts a contaminated, but survivable, orbital environment in which normal operations can continue economically, and with relative safety.

## F. Adverse Environmental Impacts on Astronomy

96. The situation with regard to radio astronomy remains extremely discouraging. The pressure on bandwidth remains relentless. Commercial developments now in the planning stage suggest a spread to higher frequencies. Since the XXIInd General Assembly of the International Astronomical Union in the Hague in August 1994, the ICSU Working Group on Adverse Environmental Impacts on Astronomy has been endeavouring to find suitable indices to measure this impact. The aim of such an index would be to obtain an unequivocal representative measure of the particular adverse impact to which it refers, which is simple to obtain and cheap to administer. Some radio observatories routinely monitor radio interference, but not necessarily at the same levels of sensitivity as their operational telescopes.

97. In the area of space debris pollution of astronomic observation, an early agreement on an index of adverse impact might be reached. There are only three major international Schmidt cameras in operation: the Mt. Palomar Schmidt in California, the Anglo-Australian Schmidt in Australia and the European Southern Observatory Schmidt in Chile. There is a feeling that a straightforward index of debris trails per plate or per hour of exposure would be an adequate, readily determinable index. Not only would this information be of value in establishing and monitoring the astronomical complaint but it would also assist in establishing the trend in production/reduction of debris in the size range recorded on deep sky plates.

98. The prospect of advertising from space, using solar reflectors or other techniques to produce bright images, is the ultimate fear for the observational astronomy community. This prospect has never before

seemed so threatening as it is now. The beaming of solar power from space is also once again under discussion. The first suggestion for advertising from space was the proposal by the Eiffel Tower Society to mark the tower's centenary in 1989 by launching into space a ring of reflectors appearing in the sky about the size of the full Moon and about as bright. The, so called, Ring of Light would orbit with a period of about 90 minutes reflecting sunlight towards the Earth. That this would be a catastrophe for any form of deep sky astronomy can be easily understood and, that while not necessarily a catastrophe for other forms of astronomical observations, they would clearly be compromised to some degree.

99. Advertising from space must reflect sufficient sunlight to render the advertisement at least as bright as the full Moon. If not, it would have little impact on its putative audience. Alternatively, a similar, or greater, brightness must be produced by other means, e.g. lasers. While the first such experiment would be unique, were it successful, it would be followed by many more such advertisements. A sky continually lit by several artificial Moons simultaneously would effectively kill any deep sky astronomy and most of the remainder of observational astronomy at optical and near infrared wavelengths. The solar reflector and other downward directed illumination from space has the potential to kill optical observational astronomy completely.

100. Proposals for two such projects have appeared. The Space Billboard, a kilometre-sized solar reflector was proposed in 1993 and in 1994, the press published the story that SkyTV was considering a scheme to use space-borne lasers to project its logo as a hologram. Neither project was envisaged to have a long lifetime but that is not the main concern for astronomers. Both are indications of commercial thinking on the use of space. Advertisers would not be satisfied with the expense involved in such a project if it only offered several days exposure and advertisers would likely seek longer-lived advertisements in dark skies. The laser hologram, allegedly deemed feasible by NASA, points the way to utilizing the sky outside the twilight period and, at possibly, greater light intensities than could be achieved by a solar reflector. It is this prospect that the astronomical community view with such dismay, i.e.. the complete demise of optical observational astronomy. A further project in this area is the Russian Znamya project, a focused reflector designed to produce outdoor illumination. This project is of a different type to the advertising reflectors as it has practical usefulness in regions where more traditional forms of street lighting may not be available. For astronomy, however, a focused reflector may be more damaging than a simple plain reflector.

101. Another area of concern to both optical and radio astronomers is the recent revival of interest in a proposal to beam solar power to the Earth by means of microwaves. Solar energy, collected by multiple reflectors, would be converted to microwaves, beamed to terrestrial receivers and converted to electrical power. Plans are being suggested to supply up to 30 per cent of the world's power requirement by this means by 2040. The proposal at face value is very attractive -- it collects power from a cosmic source so there are no financial or environmental generation costs -- only of collection and transmission. The effect on astronomy, however, could be devastating. The collection of solar radiation would be very visible and for a smaller scale proposal to collect half the annual power used in the United States, it has been estimated that it would be like having 60 Venuses spread permanently over 60 degrees of the sky. The effect would be to make certain parts of the sky "no go" areas for optical astronomy.

102. Optical and radio astronomy will become extinct if plans for space advertising, reflection of sunlight and beaming of solar power become reality. It is futile to argue that astronomy can be done from the backside of the Moon or that radio astronomy will make good use of the effects of such interference by exciting advances in technology. In principle, both arguments might have an element of truth but are the space advertisers, the solar reflectors and the space power transmitters really going to accept the cost of putting astronomy on the Moon on the same time scale as it may be possible to place advertisements in, and transmit solar power from, space -- and then agree to maintain the lunar observatories in perpetuity? Advances in technology certainly may open new opportunities, but defence against noise often lead to further degradation of the already weak cosmic signal and it is all too frequent that radio astronomers find that advances in technology are hijacked by the imperatives of commerce to the detriment of radio astronomy.

## G. The Use of Nuclear Power Sources in Outer Space

103. According to research conducted in the Russian Federation, the safe use of nuclear power sources (NPS) in space could be guaranteed in two ways: by keeping the NPS construction intact (in the case of Radioisotope Thermoelectric Generators [RTG]); or by allowing the dispersion of NPS fuel in case of accidents (for nuclear reactors). The following accidents could occur during the launch of NPS into orbit: an explosion followed by a shock wave and debris bombardment, fire with fluctuating flame temperatures, atmospheric re-entry with corresponding aerodynamic heating and impact on the Earth's surface.

104. For RTGs, thermoelectric and thermionic systems, the non-dispersion of the radioisotopes is attained by proper heat insulation of the carrying capsule. For example, the construction of the radioisotopic thermal elements used on the Russian Federation's Cosmos-84 and Cosmos-90 satellites (circular orbit at 1,500 km, power 20 W), used polonium inside a pressurized capsule capable of withstanding explosions, fire, atmospheric re-entry with orbital velocity and impact on concrete surfaces at 100 m/s. Similarly, the Lunakhod-1 and -2 moon rovers used thermal elements from polonium-210 (thermal power 1,000 W) that could withstand re-entry with escape velocity and impact on concrete at 85 m/s. The automatic docking system of the Salyut-1 orbital station used gamma-source from thulium-170 with a thermal power 40 W. A capsule containing pellets of thulium oxide was ejected from the station, safely re-entered the atmosphere and landed in the Pacific, with no adverse environmental effects.

105. For its proposed small Martian automatic stations and rovers, the Russian Federation is testing RTGs based on plutonium-238 with 5 W of power. Capsules containing plutonium dioxide can withstand explosion, fire onboard the Proton launcher, re-entry with escape velocity and impact on concrete or rocky surface at 80 m/s. More powerful RTGs (450 W) are equipped with special thermal isolation and screening.

106. For nuclear reactor accidents during the launching phase (until separation of the payload fairing), safety is guaranteed by a compact "cold" (non-activated) reactor kept in a subcritical state even in case of deformation, partial destruction of the shield and contamination by water or wet sand. In the final stages of the orbit injection (after fairing separation), there is a possibility of the "compact" solution or dispersion of the reactor. Dispersion is attained by active or passive systems, which should be extremely reliable under different conditions. In addition, the following are used to ensure the safety of low-orbiting NPS reactors:

a) systems for transfer of NPS from working into disposal orbit (basic system);
b) systems for dispersion of the reactor;
c) system for aerodynamic dispersion (ADS); and
d) system for explosive dispersion (EDS).

The latter three are redundant systems used if the basic system fails.

107. Reactors of some low-orbiting Cosmos satellites use a thermoelectric convertor with a liquid metal heat transfer agent. Aerodynamic disintegration of the reactor and dispersion of the fuel (uranium-molybdenum alloy with enriched uranium-235) is performed by ADS by ejecting the assembly of fuel rods from the reactor casing. A new system is currently under development. The reactor has construction locks with two positions. During launching, parts of the reactor are separated and therefore subcritical. After successful orbital injection, parts are mechanically relocated into the compact body and the reactor becomes operational.

108. Among the areas of difficulty identified in the existing Safety Principles for the use of NPS in outer space are the exclusion of important areas such as nuclear propulsion; their formulation in technology dependent terms which are becoming outdated as new developments occur; and some lack of consistency with the better-developed safety principles for terrestrial NPS. Although there is as yet no consensus on a

framework for a revised set of Principles, it seems inevitable that any revision must include the principle of justification, the requirement to demonstrate a net positive benefit from the use of NPS in space. According to the United Kingdom, this requirement for justification of risks is fundamental to the radiological protection principles promulgated by the International Commission on Radiation Protection (ICRP) and is assumed in the International Atomic Energy Agency's (IAEA) considerations of nuclear safety.

109. Thus, to satisfy the justification principle for the use of NPS in space, it seems necessary not only that there is a global net positive benefit but also that within each country at risk, the benefits are sufficient to justify that risk. It also seems necessary to ensure that even within one country, any individual not sharing in the benefits is only subject to a negligible level of risk. In practice, the low overall level of risk from NPS in space should not make this requirement onerous. For a minority of countries the risk may not be justified for some classes of mission because they gain little or no benefit, although this problem could be eliminated in most cases if the *de minimis* argument is acceptable. However; some classes of mission could be difficult to justify.

110. The sub-population of known NPS in orbit comprises 45 objects arising from the COSMOS series of satellites. All have orbit inclinations close to 65° (64.4°-65.8°) and hence can potentially impact most countries. According to a study conducted by the United Kingdom, the probability of these NPS re-entering at a particular latitude has a distribution which is strongly peaked at the orbit inclination around 65°. The orbits are near circular, with a maximum eccentricity of 0.0086, and apogee altitudes ranging from 635-937 km corresponding to orbital lifetimes of about 60-600 years barring debris collisions or other external interference. The effect on these orbital lifetimes of collisions with debris could have a significant impact on the level of re-entry risk.

111. It is estimated that the largest number of possible re-entries would take place over Russia (5) and Canada (2-3) due to their extensive land area spanning the most probable re-entry latitudes. Countries with more than a 40 per cent chance of a re-entry impact are the United States, China, Brazil and Australia and a further ten countries have more than a 10 per cent chance of re-entry impact. There is then a very gradual decline in probability among the remaining countries. Assuming each re-entry is detectable and a recovery operation is carried out as effectively as was done for Cosmos-954, the risk to individual members of the general public seems likely to be below a reasonable *de minimis* level. However, exceptions could arise in remote rural communities if large, highly-active components were recovered by unskilled hands.

### H. Remote Sensing of the Earth

112. Remote sensing of the Earth is one of the most important space activities conducted by France. In this context, France cooperates with ESA on the ERS and Envisat programmes, with the United States on the Topex/Poseidon programme and also has its own national programme, SPOT. Even in this national programme, there is a high level of bilateral cooperation with Belgium and Sweden aimed at continuous operation of both the ground and space sector. The space segment consists of the following satellites: SPOT-1 (launched 22 February 1986), SPOT-2 (22 January 1990) and SPOT-3 (26 September 1993). The next satellite (SPOT-4) is scheduled to be launched in 1997 and will be equipped with multispectral detectors with resolutions up to 10 m and with the possibility of producing stereoscopic images. Recently, France decided to continue this programme with the SPOT-5A and -5B satellites which will have improved parameters (resolution up to 5 m, operational provision of stereoscopic data, and digital recording systems instead of the current mechanical tape recorders). These improved satellites should be launched in 2002 and 2007, assuring continuation of the programme at least until 2012.

113. France has a long tradition of cooperation with developing countries and the SPOT programme is an important part of this effort which provides technical assistance and transfer of technology aimed at the

development of indigenous capacity in the field of remote sensing technology. Images from SPOT satellites are distributed without discrimination and free access is always guaranteed. Some developing countries obtain such data directly from receiving stations located on their territory or in neighbouring countries. France often provides financial and/or technical support for these stations.

114. France also assists developing countries in the utilization of remote sensing data for geology, agriculture, and urban planning applications. In addition to providing fellowships at French universities, there are special seminars and short and medium term courses. French experts frequently consult with specialists in corresponding facilities in developing countries (*inter alia*, Indonesia, Kenya, Nigeria, Thailand). Such cooperation is usually performed in three phases: research, pilot projects and transfer of technology, and programmes of autonomous data utilization in particular country. Recent examples are the establishment and support of the National Centre in Tunisia, preparation of the agricultural inventory in Egypt, an agricultural cartographic project in Algeria and methodology of monitoring of deforestation in South-East Asia. There are already some economically viable examples of the use of remote sensing technology -- water drilling in the Sahara desert was 50 per cent successful using classical methods and 85 per cent successful using satellite remote sensing.

115. The SPOT programme also plays an important part in international monitoring of the Earth environment. It contributes into various GIS data banks with data on renewable natural resources in the Philippines and Bangladesh, river pollution problems in China and monitoring of soil erosion to prevent disasters in Peru, Chile, Colombia and Taiwan. France is also contributing to worldwide environmental monitoring programmes such as PMRC and IGBP.

116. The main contribution to the World Ocean Circulation Experiment (WOCE) ocean monitoring programmes is made by the French/United States Topex/Poseidon altimetric satellite which was launched on 10 August 1992 and is still perfectly functional. The latest estimates of the root mean square (RMS) error in the determination of the local instantaneous level of the ocean is 4.7 cm, which is significantly better than the expected 13.4 cm. It is, however, still above the 2 cm accuracy needed for monthly mean sea level in the WOCE project. Data analysis revealed direct evidence of the seasonal variances of several centimetres in the sea topography and propagating effects of the climatic anomaly known as El Niño.

117. To assure the continuity of this successful oceanographic programme, CNES, together with NASA and NOAA, is preparing a study on a possible series of small operational altimetric satellites. A special instrument, Scarab, used for long-term monitoring of the Earth's radiation balance has been developed and launched on the Russian Meteor satellite on 24 January 1994. The second instrument will be launched on another Meteor satellite in the first quarter of 1996 and subsequently on ESA's Envisat and Metop satellites. For the later satellite, an Infrared Atmospheric Sounding Interferometer (IASI) is being developed by France and Italy. Its high spectral and vertical resolution should enable precise measurement of the temperature and humidity profile of the troposphere as well as the integral content of ozone, methane and carbon monoxide.

118. The Polder radiometric imaging polarimeter, scheduled for launch on Japan's Advanced Earth Observation Satellite (ADEOS) in 1996, is a French contribution to the international Global Change programme. In principle, it should be able to monitor global visible radiation reflected by clouds, aerosols and ocean and land surface. For the first time, it would be possible to simultaneously measure polarization and multispectral characteristics of such reflected radiation. From such data, certain physical and optical characteristics of clouds and aerosols, as well as parameters of ocean phytoplancton and the continental biosphere, could be derived.

119. The French system of satellite collection and distribution of data from the worldwide network of small platforms, called Argos, has been in operation for more than 15 years. It is used for operational monitoring of volcanic activity in Mexico and Indonesia, flooding in Niger and tracking the movement of animals (at

present, 800 animals are equipped with Argos transmitters). The system has also proved useful for monitoring the position of dangerous materials in transit.

## I. Spin-off Benefits of Space Technology

120. Following the recommendations of the United Nations Committee on the Peaceful Uses of Outer Space adopted during its meeting in June 1991, the United Nations Industrial Development Organization (UNIDO) developed an outline for a programme called Realizing the Benefits of New Technology Spin-Offs in Developing Countries (with particular reference to space technologies) which is mentioned in the Secretary-General's Report on Coordination of Outer Space Activities Within the United Nations System. Such a programme was felt to be a logical extension of UNIDO's response to the technological breakthroughs achieved in space activities and experience, with their spin-offs in both industrialized and developing countries. More specifically, it added an extra dimension to the organization's activities in the field of emerging new technologies, an area in which UNIDO has been active since the early 1980s.

121. The promotion of this programme generated a considerable amount of interest from developing and developed countries to expand some elements of the proposed programme and its practical implementation. In response, UNIDO organized an expert group meeting on the benefits of High Technology Spin-Offs for Developing Countries, which was held from 20 to 22 December 1993 in Vienna. The meeting focused on the exchange of experiences in the application of spin-offs, both in developed and developing countries, and on the identification of common elements and approaches in this area as well as on the possibilities and the potential for international cooperation in this area. The United Nations Office for Outer Space Affairs also actively participated in that meeting.

122. As a result of the expert group meeting, an international work programme was outlined for a period of three years. The key features of this programme are technology spin-off monitoring, assessment and forecasting, establishment of relevant databases, development of solutions to specific problems related to the technology transfer process and the funding mechanisms for its elements. The programme also includes assistance to countries in formulating and implementing a national policy and strategy in this area, as well as providing an international framework for the transfer and application of high-technology spin-offs.

123. As a part of this programme, UNIDO will publish a quarterly "Monitor" that will be fully devoted to this particular subject. Its first issue will be available for distribution in March 1995. A series of New Technologies Round Tables will be organized by UNIDO on a regional level in 1995-97 where high technology spin-offs will be one of the major topics for discussion.

## J. The Use of Satellite Systems for Air Traffic Management

124. In accordance with the 1944 Chicago Convention, which drafted the "Convention on International Civil Aviation" and created the International Civil Aviation Organization (ICAO), the organization was charged with the task of charting a course of action to be taken to coordinate the identification and development of requirements of international civil aviation on a worldwide basis. Within this framework, ICAO adopts and amends from time to time and as may be necessary, international Standards and Recommended Practices (SARPs) to cope with the aims and objectives of the organization which includes the development of the principles and techniques of international air navigation and to foster the planning and development of international air transport.

125. Recognizing the increasing limitations of contemporary air navigation systems and the resulting need for improvements to take civil aviation into the 21st century, the ICAO Council established in 1983 the Special Committee on Future Air Navigation Systems (FANS) to make recommendations for a long-term projection for the development of air navigation for international civil aviation over a period of 25 years.

The committee performed a comprehensive assessment and analysis of the characteristics and the capabilities of the present system, as well as of the status of its implementation in various parts of the world. The examination confirmed that three essential factors limited the use and expansion of aircraft systems to meet civil aviation's growing requirements for the future decades. These were:

a) propagation limitations of current line-of-sight systems and/or accuracy and reliability limitations imposed by the variability of propagation characteristics of the available non-line-of-sight systems;

b) the difficulty of implementing the present systems in large parts of the world and operating them in a consistent and reliable manner; and

c) limitations inherent in the exclusive use of voice communications and the lack of the digital air/ground data interchange systems to support modern automated systems in the air and on the ground.

126. These shortcomings were intrinsic to the systems themselves and to the means by which they were implemented. Although their effects were not the same for every part of the world, it was evident that one or more of these factors were inhibiting the further development of air navigation almost everywhere. At the same time, travel growth through 2010 was forecast to average 5.4 per cent. At this rate, the current demand for air traffic will double by 2005 and be over 2.5 times greater by 2010. It was quite clear that any new system, to be worthwhile implementing, must overcome these limitations to allow air traffic management to evolve on a global scale, independent from location, time of day and other constraints and, in a most cost-effective manner, with maximum return on investment.

127. All these aspects were discussed by the FANS Committee which resolved that complementary to certain terrestrial systems, satellite-based communications, navigation, and surveillance systems (CNS), would be the key to world-wide improvements, and in fact, the only viable solution in the long-term to overcome the shortcomings of the current system and to fulfill the global needs and requirements for the foreseeable future. In its long-term projection for the coordinated evolutionary development of air navigation for international civil aviation, the committee developed a system concept, based largely on satellites, for CNS and for the evolution of air traffic management, generally referred to as ATM. The new CNS/ATM concept is intended to gradually implement satellite technology while building on the existing CNS system and technologies without making them obsolete, at least not in the short-term. It offers improvements that can be implemented through an evolutionary transition on a local scale, as requirements dictate, while at the same time meeting the need for global coordination. In general, the ICAO CNS/ATM concept allows for a judicious mix of satellite technology and the best of line-of-sight systems to achieve an over-all optimum result.

128. With the new CNS system, communications with aircraft for both voice and data would be achieved largely by direct satellite-aircraft links operating in the frequency band exclusively allocated to the aeronautical mobile satellite service (AMSS). In terminal areas and where line-of-sight limitations are not a problem, very high frequency (VHF) and secondary surveillance radar (SSR) Mode S data links would also be used. SSR Mode S will provide, together with independent surveillance, an air-ground data link for transmission of high-rate data for Air Traffic Service (ATS) purposes. The communications system architecture provides for a range of capabilities from basic low speed data to high speed data and voice. The various communications subnetworks (AMSS, VHF digital link (VDL) and Mode S data link) will be integrated through an aeronautical telecommunication network (ATN).

129. With regard to navigation, ICAO is developing the concept of required navigation performance (RNP) which will define the performance required in a particular airspace or phase of flight, and enable that required performance to be achieved with any of a variety of navigation equipment. The ICAO systems concept, is, however, quite definite in its preference of the global navigation satellite system (GNSS) for navigation. This system includes satellite constellations, aircraft receivers and integrity monitoring facilities. ICAO views

GNSS as the key feature of the future concept, providing independent onboard position determination. It is expected to evolve to become a sole means of navigation, eventually replacing the current long- and short-range navigation systems such as Omega, non-directional radio beacon (NDB) and VHF omnidirectional radio range (VOR). Additionally, GNSS will provide global coverage, will be accurate enough to support en-route navigation and will meet non-precision type approach needs, perhaps even limited or full precision approaches in the future.

130. Significant technical and operational experience has been gained through the CNS/ATM trials conducted by various countries in cooperation with airline operators and other aviation industry organizations throughout the world. The objectives of these trials include the assessment of system integrity, evaluation of aircraft antenna performance and validation of AMSS and VHF Digital Link Standards and Recommended Practices (VDL SARPs). The trials are also used to validate ADS SARPs and to assess methods of processing and displaying ADS-derived aircraft positions and flight plan data. The performance of satellite data link communications and, in particular, the integrity of the transmission of aircraft position reports indicate the suitability of ADS in oceanic airspaces. It seems very likely, therefore, that the system can meet one of the initial objectives, i.e. replacing voice position reporting by data transfer techniques.

131. ADS trials are now being conducted in the Pacific and North Atlantic regions and are planned in other parts of the world. Of particular significance in this respect are the recent initiatives reported by Australia, Brazil, Canada, China, France, Iceland, Italy, Japan, Norway, Russian Federation, Spain, Sweden, United Kingdom, the United States, Agency for the Safety of Aerial Navigation in Africa and Madagascar (ASECNA), European Organization for the Safety of Air Navigation (EUROCONTROL) and Inmarsat, many with the support of International Air Transport Association (IATA) member airlines.

## K. Planetary Exploration and Astronomy

132. The Space Research Institute of the Austrian Academy of Sciences in Graz is involved in several major scientific spacecraft missions. The four-spacecraft Cluster mission is carried out jointly by ESA and NASA and is aimed at probing the Earth's plasma environment with four identical spacecraft on almost identical orbits. Its primary scientific objective is the analysis of boundary layers and wave fields in the plasma environment near the Earth in three dimensions. In 1993 and early 1994, the manufacturing of instrument hardware for four payloads had its most active phase. It is currently being followed by an extensive test period of the spacecraft with the experiments. Austria contributes hardware to Cluster for two experiments: an instrument to actively control the floating potential of the spacecraft with respect to the ambient plasma, called an active spacecraft potential control (ASPOC), and a fluxgate magnetometer (FGM).

133. Electrical charging of the outer surface of a spacecraft has serious effects on measurements of the cold plasma. ASPOC uses ion emitters of the liquid metal ion source type for charge neutralization. This is a continuation of earlier investigations related to spacecraft charging and the participation in active experiments with charged particle beams from sounding rockets and Spacelab. ASPOC is being built by an international consortium headed by the Space Research Institute with contributions from the Research Centre at Seibersdorf (Austria), the Space Science Department of ESA/European Space Technology Centre (ESTEC), Norwegian Defence Research Establishment, University of New Hampshire (United States), Naval Postgraduate School (United States) and the Jet Propulsion Laboratory (United States).

134. The Interball mission consists of two pairs of satellites, one in a fairly low orbit (with an apogee of 20,000 km) and the other with an apogee of 200,000 km. These two very different orbits were chosen in order to cover the auroral and the tail regions of the Earth's magnetosphere. Each of these large satellites will be accompanied by a small subsatellite (built in the Czech Republic with experiments from Austria, France, Germany, Poland, Slovakia, Romania and Russian Federation), in order to allow differentiation between spatial and temporal effects. Aboard the low-apogee main satellite, the potential will be controlled by an in-

strument called SPEX, which is similar to ASPOC in the Cluster mission. The goal of SPEX is the stabilization of the spacecraft potential in order to provide accurate measurements of the cold plasma components. SPEX is a joint project of the Space Research Institute and the Research Centre Seibersdorf in collaboration with the Space Science Department of ESA/ESTEC.

### L. Space Medicine

135. The Austrian Society for Aerospace Medicine (ASM) was established in 1991, following the successful completion of the joint Austro-Russian Space Project "AUSTROMIR", to pursue the following aims:

a) to plan, coordinate and implement scientific research in the field of aerospace medicine and space life sciences on a national and international level;
b) to foster inter-disciplinary approaches;
c) to adapt instrumentation and methods employed in space medical research to terrestrial applications for medical diagnosis, therapy, prevention and rehabilitation;
d) to issue publications and provide information to the general public concerning aerospace medicine and space life sciences; and
e) to collaborate with partner institutions at a national and international level.

136. The Society is comprised of the ASM Institute for Space Neurology, ASM Institute for Adaptational and Space Flight Physiology, ASM Institute for Space Exercise and Physiology, ASM Institute for Space Dosimetry, and ASM Institute for Space Qualification and Testing.

137. As part of the Russian National Space Programme, the Russian physician cosmonaut Valery V. Polyakov lifted-off from Baikonur on 8 January 1994 with the crew of Soyuz TM-18 to investigate the effects of long-term spaceflight, especially weightlessness, on the human body. Dr. Polyakov was scheduled to remain onboard the Mir Space Station for a period of at least 14 months, breaking the space endurance record. The Russian Long-term Flight (RLF) Project, using the Austrian technology, is viewed as an important milestone in the foreseen future project to Mars. The scientific/medical part of the complete RLF project is managed, controlled and coordinated by the Institute of Bio-Medical Problems (IMBP), based in Moscow.

138. The RLF project has been broken down into three phases: Phase 1 to the end of June 1994; Phase 2 from June 1994 to the start of November 1994; and Phase 3 from the start of October 1994 to the start of March 1995. In each of these phases, when the Station Commander and the Station Engineer were rotated with new crews from Earth, Dr. Polyakov remained onboard as the Station Scientific Officer. As it had been planned, during the overlap between Phases 2 and 3, Mir was visited by ESA astronaut Ulf Merbold. In Phase 3 a Russian female cosmonaut Yelena Kondakova worked on Mir.

139. Due to the successful cooperation in the field of space medicine between Austria and Russia during the AUSTROMIR project and the positive relationships that were established between scientific personnel on both sides, the ASM was invited to fly improved versions of the successful medical experiments from the AUSTROMIR project on the RLF project. These were:

MONIMIR - Eye, Head and Arm Coordination and Spinal Reflexes in Micro-g.
RLF-MYO-MOTO-SCAN - Neurophysiological and Metabolic Analysis of Human Muscular Functions under Controlled Motion Patterns in Micro-g.
OPTOVERT - Vertical Optokinetic Stimulation Used to Examined Central Orientational Processes.

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|---|---|---|
| PULSTRANS/SCHLAF | - | Cardiovascular Monitoring in Micro-g. |
| MIKROVIB | - | Investigation of Tremors in Micro-g. |
| COGIMIR | - | How to Measure Cognitive Functions in Space. |
| BODYFLUIDS/INTERSTITUM | - | Regulation of Body Fluids with Changed Gravitational Load. |
| ADLET | - | Radiation Measurements Inside MIR. |
| MIRGEN | - | Evaluation of Space Flight on Genetic Information. |

140. With respect to the actual use of the experiments, there was an accord between Austria and IMBP that each experiment will be used at least four times by Dr. Polyakov as well as by the other the cosmonauts, as their daily duties/tasks allow. In the first phase of the flight, due to the tight project schedule, the AUSTROMIR medical experiments were utilized without modification or change to the experimental techniques or methodologies. The experiments were checked-out in orbit and any repairs required were made. Consumables were re-supplied from Earth. For the second and third phases of the flight, the methodology of some of the scientific experiments have been refined and further developed, as well as optimization of the experimental equipment. The new versions of the equipment and the accompanying software were all delivered to IMBP by mid-July 1994.

141. The use of the experiments by a number of cosmonauts, over a substantial period of time will lead to a large quantity of data which should provide important insights with respect to the effects of long duration space stay. This data will also be used as a spin-off to ascertain certain basic knowledge with respect to the functioning of the human body, its central nervous system and the development of new diagnostic and therapeutical concepts that may be used in normal everyday medicine. Using the crew medical examinations taken before, during and after each flight, as well as the medical information from the control subjects on the Earth, it will be possible to determine the degree of change that the effects of long duration space flight have on the human body. The analysis and evaluation of the data collected will take place in cooperation with IMBP, and will be ready for publication by the end of 1996.

## Appendix

## LIST OF SCIENTIFIC AND TECHNICAL PRESENTATIONS

### I. SYMPOSIUM ON APPLICATIONS OF SPACE TECHNOLOGY FOR EDUCATION WITH PARTICULAR EMPHASIS ON ITS USE IN DEVELOPING COUNTRIES, ORGANIZED BY COSPAR AND IAF

The first session of the symposium, entitled "Policy issues regarding space education", was co-chaired by Mr. H.H. von Muldau, representing IAF, and Mr. K. Kasturirangan, representing COSPAR. The second session of the symposium, entitled "Applications of space technology in space education", was co-chaired by Mr. S. Bauer, representing COSPAR, and Mr. H. H. von Muldau, representing IAF. Mr. R. Gibson of the IAF was the Rapporteur for both sessions of the symposium.

"Applications for space technology for education - The Indian experience, solutions and perspectives of the future," Mr. M. G. Chandrasekhar, Scientific Secretary, Indian Space Research Organization (ISRO), India.

"French experience in space education," Mr. L. Laidet, Directeur de la Communication du Centre national d'études spatiales (CNES), France.

"South American perspectives on the application of space technology for education: the example of Brazil," Ms. F. de Oliveira, Public Affairs Office, Instituto Nacional de Pesquisas Espaciais (INPE), Brazil.

"ISRO video: Interactive satellite-based television broadcasting systems for education and training - towards operational systems," Mr. K. Kasturirangan, Chairman, ISRO, India.

"Space education activities in the United States," Ms. Beth Masters, Director of International Relations, National Aeronautics and Space Administration (NASA), Unites States.

"University education in space science and engineering," Mr. D. Abir, Tel Aviv University, Israel National Commission on Space Research.

"The intelligent satellite data information system ISIS of DLR," Mr. G. Strunz, Deutsche Forschungsanstalt für Luft- und Raumfahrt e.V. (DLR), Deutsches Fernerkundungsdatenzentrum, Germany.

"Summary of the Symposium," Mr. R. Gibson, International Astronautical Federation.

### II. OTHER SCIENTIFIC AND TECHNICAL PRESENTATIONS

"The influence of the Earth's gravity field on the space debris orbital evolution," Mr. E. Wnuk, Astronomical Observatory Poznan, Poland.

"Satellite systems and their impact on the orbital environment: a global management plan," Mr. R. Crowther, Defence Research Agency, Farnborough, United Kingdom.

"Space debris research in France," Mr. Y. Trempat, Centre National d'Etudes Spatiales (CNES), Toulouse, France.

"Modelling the low Earth space debris environment," Mr. M. G. Chandrasekhar, Indian Space Research Organization, India.

"Space Debris - Research in ESA," Mr. W. Flury, ESOC, European Space Agency.

"Use of Nuclear Power Sources in Space," Mr. B. Wade, AEA Technology, United Kingdom.

"Nuclear power sources in outer space," Mr. V. S. Nikolaev, Ministry of Atomic Energy of the Russian Federation.

"Adverse Environmental Impacts on Astronomy," Mr. D. McNally, International Astronomical Union.

"Down-to-Earth education," Mr. W. Elliott and Ms. W. Loly, Winnipeg, Canada.

"Spacecraft potential control and related research," Mr. W. Riedler, University of Graz, Austria.

"ITU and international geostationary-satellite orbit/spectrum management," Mr. P. Korobenkov, International Telecommunication Union.

"Austrian Society for Aerospace Medicine and the Russian long-term flight project," Mr. H. Hinghofer-Szalkay, Austria.

"GATES: Global Access to Telehealth and Education Systems," Ms. Y. Ban, Mr. P. Gilson, Mr. N. Steinhoff, Ms. B. Rossi-y-Costa, International Space University.

"Spin-off benefits of space technology," Mr. V. Kojarnovitch, UNIDO.

"French space efforts in the area of the environment," Ms. M. Chevrel, CNES, France.

"Globe Programme," Ms. Margaret Finarelli, Globe Programme, United States.

"Uses of SPOT satellites in developing countries," Mr. Jean-Claude Cazaux, SCOT Conseil, France.

"Use of space technology for education," Ms. Evgeniya Volokhova, Ministry of Education of the Russian Federation.

"Air traffic management programme of ICAO," Mr. Victor Iatsouk, Communications Section, ICAO.